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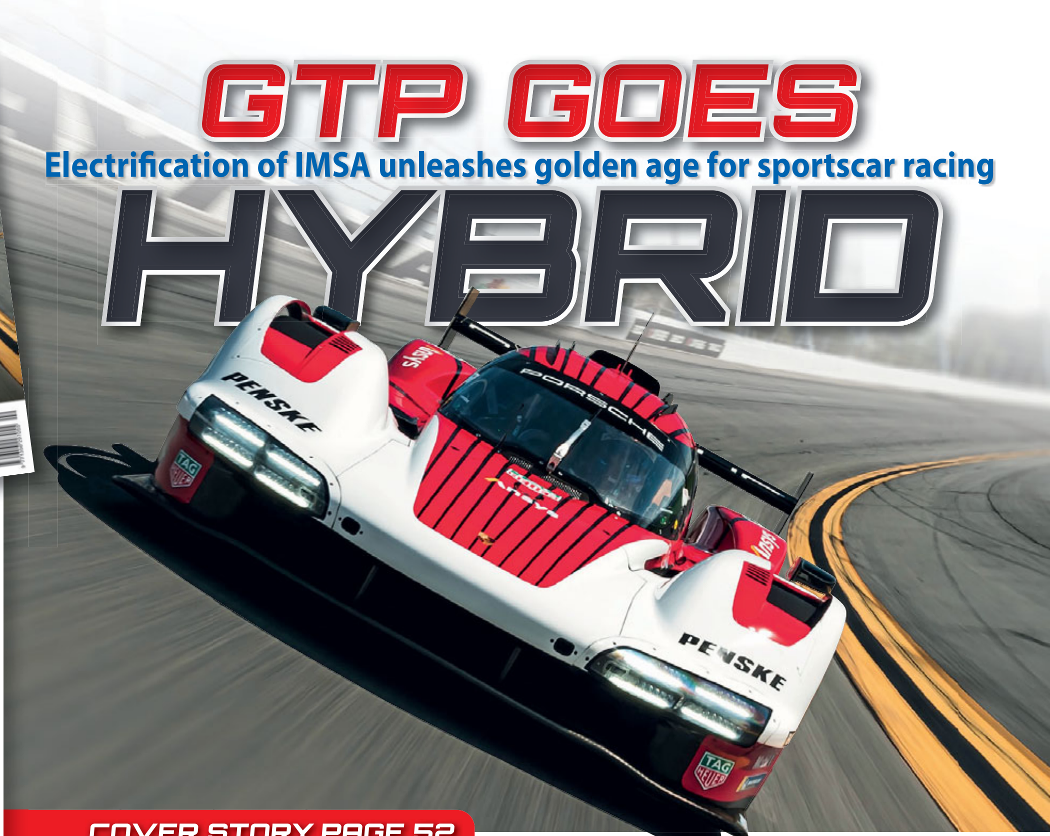
GTP GOES
Electrification of IMSA unleashes golden age for sportscar racing
HYBRID

COVER STORY PAGE 52

ON THE COVER

6 **WMS TECH AWARD WINNERS REVEALED**
The technical feats of the innovators who helped shape the 2022 season were recognised at the World Motorsport Symposium. By Mark Skewis

38 **THE FIRST CUSTOMER HYDROGEN ICE**
Chris Pickering talks to the key figures behind a revolutionary new engine that could disrupt the future of motorsport

52 **ELECTRIFICATION OF IMSA GTP**
This month's Rolex 24 looks to the future with a nod to the past, as the Grand Touring Prototype (GTP) class is reborn – with hybrid powertrains. Chris Pickering talks to IMSA technical director Matt Kurdock

6 **INDUSTRY NEWS**
Electric NASCAR experiment could herald EV series; IndyCar jettisons new engines to save race to electrification; Super Formula's new car to feature hybrid flax and carbon fibre bodywork; eFuels pilot plant in Chile officially opened; Audi already has 220 people working flat-out on its F1 project; sustainable fuel "a real and credible player"; Honda Civic Type R to be built for TCR; 'Attack charge' introduced for Gen3 Formula E era; Extreme E's "race without a trace"

72 **COMMENT**
Sergio Rinland explains why former Ferrari chief Mattia Binotto had the nightmare job

30 **WORLD MOTORSPORT SYMPOSIUM**
Mark Skewis offers a glimpse behind the scenes at last month's Race Tech World Motorsport Symposium

46 **TRANSMISSION TECH**
We can expect a clean sweep of fully automatic transmissions when the front-running trucks tackle this month's Dakar Rally. Mark Skewis talks to Gerard de Rooy, owner of Team de Rooy, to find out what's behind this recent transition

62 **3D PRINTING**
Team Penske became the first team ever to pull off the historic NASCAR-IndyCar title double last season. Chris Pickering discovers one of the secrets behind its success

70 **NEW PRODUCTS**
The ability to install the latest Scanivalve MPS4232 Miniature Pressure Scanner closer to measurement points could prove invaluable in wind tunnel testing. By Mark Skewis

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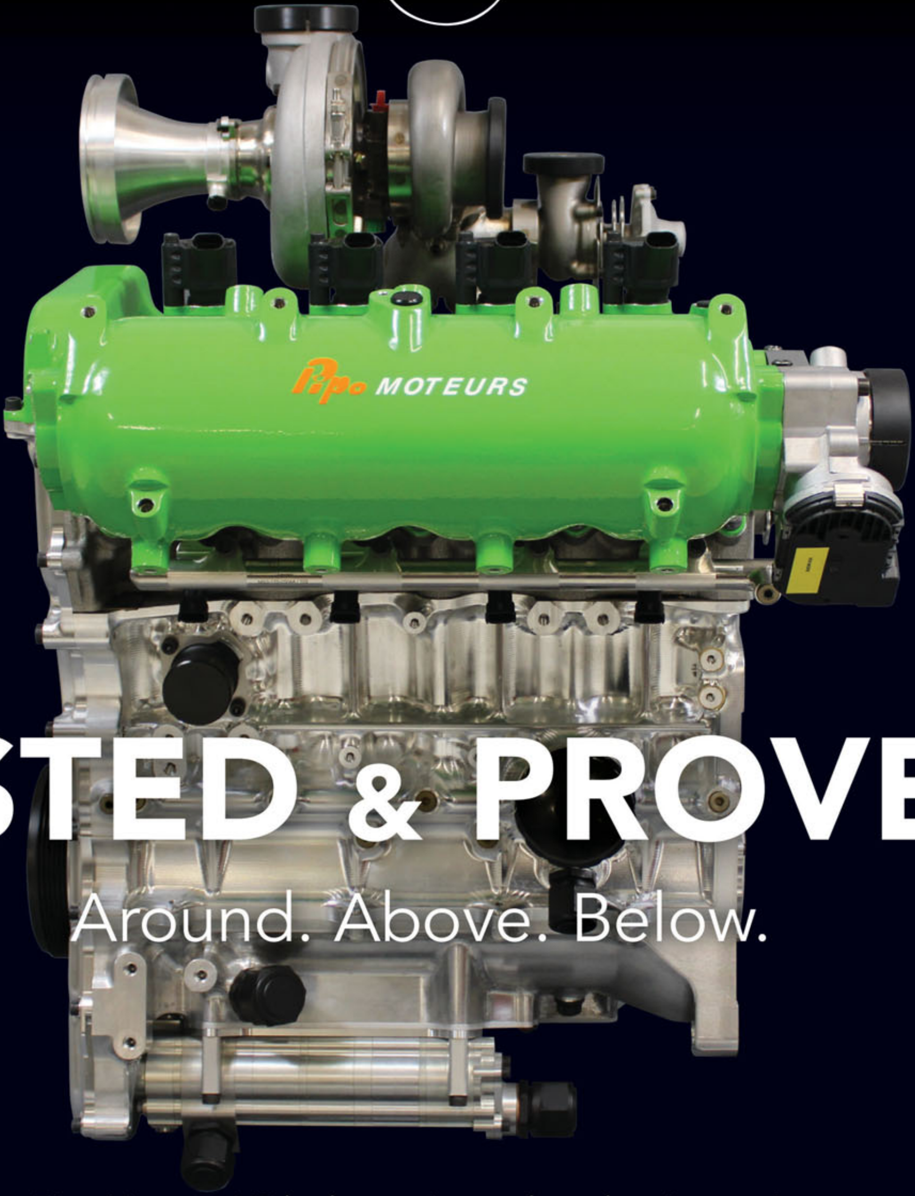

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NO MORE KICKING THE CAN DOWN THE ROAD

"**WELCOME** to the Piranha Club!" Ron Dennis told Eddie Jordan when he graduated to Formula 1. Nobody who has ever worked in the sport's top tier would disagree with that sentiment.

The bitching, the back-biting and the gamesmanship is brutal. That shouldn't come as any surprise, for motor racing was built on rivalry. It *thrives* on it.

That's why I found last month's World Motorsport Symposium – hosted so capably by the Embassy of Switzerland, in the heart of London – such a revelation. Many of motorsport's movers and shakers were in the same room, co-operating. Judging by the cacophony of chatter that accompanied every opportunity, they were revelling in it too.

The key, I think, is that they were united by common enemies: climate change and the tightening legislative net that inevitably accompanies our quest to be Net Zero.

There was an acknowledgement from all present that the time of "joyous abuse of fossil fuels" was over, that much work still needs to be done on sustainable fuels, that hydrogen is perhaps next in line, but that many issues remain to be resolved.

We need renewable energy. Lots of it. On which note, the 'Haru Oni' pilot plant for the production of synthetic fuels in Punta Arenas (Chile) was officially opened just before Christmas.

If we are to be serious, we also require a holistic approach. We have to be mindful, for instance, that the virtue of stampeding towards EVs can be counter-productive if the very act of mining for the materials their batteries require, is going to damage the environment in the process.

Another recurrent theme was that government policies are all too often being shaped by short-term soundbites rather than by science. Whatever their origin, those policies will bite, setting the backdrop against which motorsport will operate.

Take the Singapore GP, for instance. The country, an oil-refining hub, will not only ban the sale of new diesel and gasoline cars by 2030, but purge them from the streets completely by 2040!

There is no magic wand for the situation. Instead, many different solutions that will suit various applications. One thing on which there *did* appear to be agreement at the WMS, was not to let the perfect be the enemy of the good: if 95 per cent of cars in the existing ICE fleet could achieve even a small reduction in CO2 – maybe through an increase in the sustainable content of existing fuels? – that would deliver a huge leap forward.

Whatever the solutions, motorsport – like the automotive industry with which it is inextricably linked – has to accept that the climate crisis is not a can to be kicked down the road: it is no longer a dilemma for tomorrow; it is a problem right now.

The cost of doing something will be eye-wateringly high. The price to be paid for doing nothing, higher still. RT

Mark Skewis
EDITOR

RACE TECH
WMS
World Motorsport Symposium
202
Team Audi Sport

LEFT Stefan Dreyer received the Race Powertrain of the Year award, on behalf of Audi Sport, from KMG Publishing Director Soheila Kimberley

RACE TECH AWARDS HONOUR TRAILBLAZERS

The technical feats of the innovators who helped shape the 2022 season were recognised at the World Motorsport Symposium. By **Mark Skewis**

RACE TECH's 2022 technical awards recognised engineering ingenuity across a range of challenging conditions: from the demands of Formula 1, to the blast up the Goodwood Hillclimb; and from the dunes of the Dakar Rally, to the racetracks of the World Endurance Championship.

The presentations were made last month at the World Motorsport Symposium networking dinner at Mosimann's Club, in the heart of London, one of the most prestigious private dining clubs in the world.

"This year's awards reflected the fast-changing nature of the automotive landscape, but also the priceless can-do mentality that makes other industries so envious of motorsport's engineers," said Kimberley Media Group Publishing Director Soheila Kimberley.

The Race Powertrain of the Year Award was won by Audi Sport for the RS Q e-tron, with which it stunned rivals at the 2022 Dakar Rally.

Described as the most complex racecar in Audi's history – this from a brand that pioneered diesels and hybrids at Le Mans, raced throughout the DTM's manufacturer years and brought four-wheel drive to rallying – the RS Q e-tron is, in essence, a range-extended electric vehicle.

It uses motor generator units (MGUs) derived from Audi's Formula E programme to power the front and rear wheels. Under the front of the cabin sits a bespoke 52 kWh lithium-ion battery pack, meanwhile at the rear there's a two-litre turbocharged four-cylinder engine taken from the company's record-breaking DTM racer. This drives a third MGU as part of what Audi terms the car's Energy Converter, but there is no physical connection to the wheels, which are driven solely by the electric motors.

The engineers behind the project faced numerous challenges in terms of software design and hardware integration. Simply finding space for everything proved to be a mammoth task, with effectively two powertrains packaged into a single car, not to mention four separate heat exchangers and more than *four kilometres* of wiring!

The Audi RS Q e-tron overcame strong opposition from Formula E (Mercedes), Le Mans Hypercar (Toyota GAZOO Racing), and Touring Cars (Swindon Powertrain) to win the Race Powertrain of the Year Award.

"Winning this award and being able to accept it on behalf of Audi Sport in London was an emotional and incredibly special moment," said Stefan Dreyer, who, as the Head of Development at Audi Sport Racing, is responsible for the development of the innovative drivetrain concept.

"The entire team can be proud of this award," he continued. "The story from the creation of the energy converter concept during the development discussions to its realization in the Dakar Rally vehicle remains unforgettable. The courage, focus, perseverance, but above all, the identification with this concept have paid off."

The Dino Toso Racecar Aerodynamicist of the Year Award was won by McMurtry Automotive, the team behind the McMurtry Spéirling that smashed the outright hillclimb record at the Goodwood Festival of Speed.

The award is named after its inaugural and late winner Dino Toso, who was chief aerodynamicist at Renault F1 when the French manufacturer won back-to-back Formula One Drivers' and Constructors' crowns with Fernando Alonso in 2005 and 2006.

The McMurtry project is a remarkable one – it had to be to repel the opposition on a strong shortlist that included Red Bull's RB18, Peugeot's 9X8 WEC racecar and Catesby Tunnel.

Reviving the 'fan car' concept banned in F1, the McMurtry Spéirling used two fans placed behind the driver and connected through an intricate network of ducts to a sealed skirt beneath the car, creating a vacuum and giving both instant and constant downforce.

The team's initial experiments began with static test rigs, followed by trailer-mounted systems that were towed behind a separate vehicle. Next, the team bought and converted an old ambulance – the only van that they could find with a large engine ▶

"Insanely calm" strategist named McLaren Applied Female Engineer of the Year

WMS
World Motorsport Symposium
ner: Hannah Sc

RIGHT Schmitz was presented with her award by McLaren Applied's Pauline McFerran

THE pit wall strategist labelled "insanely calm" by F1 World Champion Max Verstappen has become the first recipient of the McLaren Applied Female Engineer of the Year Award.

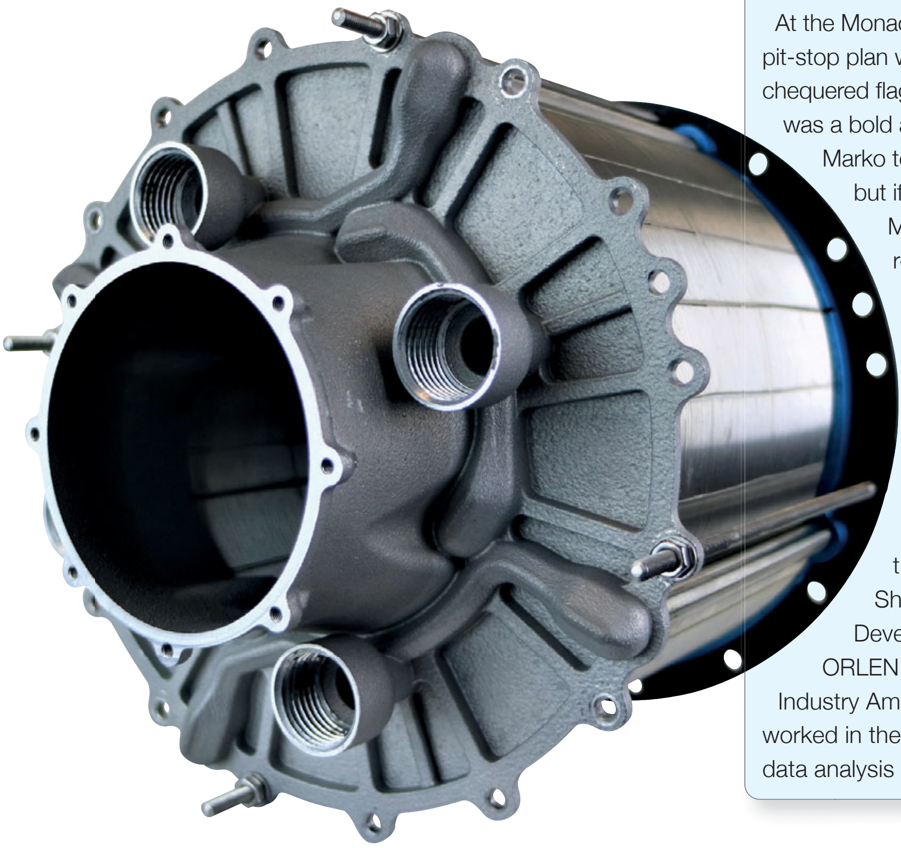
Hannah Schmitz, Principal Strategy Engineer for Oracle Red Bull Racing, was involved in an inspired strategy that won the Dutchman the Hungarian GP from 10th on the grid. He praised her as she instantly adapted to a last-minute switch to begin the race on soft tyres instead of the hard as planned, helping him undercut rivals and claim an unlikely victory.

At the Monaco GP in May the team also orchestrated the pit-stop plan which ultimately led to Sergio Pérez taking the chequered flag and Verstappen clinching a podium place. It was a bold and proactive move that prompted Dr Helmut Marko to say afterwards: "We were all exceptional, but if we won it was mainly due to Hannah."

McLaren Applied's new award is designed to recognise inspirational women blazing a trail in motorsport, which has traditionally been a male-dominated environment.

Schmitz accepted the accolade in classy fashion, stressing that in F1 you win and lose as a team.

The Cambridge University graduate, who joined Red Bull Racing as a student intern in 2009, was part of a strong three-candidate shortlist for the new prize. She beat Krystina Emmanouilides, a CFD Development Engineer at Alfa Romeo Racing ORLEN F1 Team, a Racing Pride Director and Industry Ambassador, and Charlotte Phelps, who has worked in the W-Series as senior engineer, focusing on data analysis and driver development. RT



BELOW It was a breakthrough season for Reaction Engines' thermal management technology and heavy-duty air suspension to cope with the two tonnes of additional downforce that they planned to develop! They eventually succeeded in that ambition.

Thomas Yates, Managing Director of McMurtry Automotive, collected the award on behalf of the company. "A fan car is a very novel way of generating outright track performance," he said. "The Goodwood record was a fantastic way to demonstrate the grip and corner speed of a vehicle designed from a clean sheet to be an electric fan car.

"It allowed us to shrink the proportions of the car down to that of a 1960s F1 car, as we no longer were reliant on large passive aerodynamic components like diffusers and wings. This compounded the benefit as we were able to reduce frontal area and save overall weight.

"We have overcome huge technical challenges in bringing this aerodynamic concept to real life," he added, "and therefore I must thank everyone in the company for delivering a car that can produce more than double its own weight in downforce from 0mph, whilst simultaneously being of beautiful form."

Innovative

Reaction Engines was awarded the prestigious Don Burgoon Most Innovative New Motorsport Product of the Year Award, beating stiff competition from Geobrugg, Allengra GmbH, Evolution Measurement and Ansible Motion.

The UK company's ground-breaking thermal management technology has made the leap from aerospace to motorsport in 2022. Based on patented innovative spiral architecture, its intercoolers achieved race-winning performance in Formula 1.

"It is an incredible honour to be recognised by such a respected panel for this impressive award," commented Alex Creak, Reaction Engines Applied Technologies Automotive Lead. "It means a lot to all the team who have helped turn the intercooler into reality, and we look forward to seeing what next year brings. Thank you to everyone at Race Tech for hosting this great event that celebrates and honours those in the motorsport industry."

Green Tech

Kimberley Media Group Founder William Kimberley was a passionate advocate of green technology. It was therefore a poignant moment when his widow, KMG Publishing Director Soheila Kimberley, presented the Green Tech Award in William's name.

The quest for sustainability was a recurring theme throughout the World Motorsport Symposium. Two companies which are pioneers in this field, Swiss firm Bcomp and the French TotalEnergies Group, went head-to-head on the shortlist of nominations.

Bcomp is currently helping transform the Japanese Super Formula series, for which it is providing bodywork that is 70% flax and only 30% carbon fibre for local reinforcements – an ideal combination of each material's benefits while still significantly reducing the carbon footprint.

START
START
START
MC
TDV

ABOVE The McMurtry squad's record-breaking feats at Goodwood relied on generating huge amounts of downforce

Ultimately, though, the William Kimberley Green Tech Award was won by TotalEnergies for its Excellium Racing 100 renewable fuel, which it supplied to all competitors in last year's World Endurance Championship (WEC).

Sourced entirely within the circular economy and without a single drop of oil, this biofuel draws its energy from the recycling of residual biomass from the wine industry.

Excellium Racing 100 is estimated to reduce CO2 emissions by at least 65% over its life cycle. It is produced on a base of bioethanol derived mainly from wine residues through a process of fermentation, distillation and dehydration of grape marcs and lees.

This base is then blended with ETBE (Ethyl Tertiary Butyl Ether), itself a 100% renewable component. Finally, a pack of additives from Excellium technology completes the formulation.

"The award was the perfect end to a milestone year for us," said Romain Aubry, Technical Manager of the TotalEnergies Motorsport Division. "There is still a lot to do on sustainable fuel. We delivered more than a million litres of Excellium Racing 100 this season but that is the start of the journey, not the end. We are working flat-out to develop the formulations that will carry motorsport, on two wheels and four, into the next era.

"This award is a great reward for all the effort put in by our teams: R&D, trackside, production and logistics." RT

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Electric NASCAR experiment could herald EV series

NASCAR is building an electric mule car that will appear at racetracks in 2023.

The experiment will be a 'toe in the water' exercise that allows the governing body to assess the reactions of fans and manufacturers alike. One possibility mooted is that, if feedback is favourable, the NASCAR Xfinity Series could turn into an all-electric series.

Chief Operating Officer Steve O'Donnell confirmed rumours of the mule car recently in a podcast, where he conceded that NASCAR is having to remain agile as it juggles the sometimes-conflicting desires of OEMs.

"For us, we've got to be all things to all people. And at the end of the day, we've got to be entertaining," O'Donnell said. "And people want to show up, and they want to go to an event, and they want to have fun. And what I've seen at least around [electric vehicle] racing so far, there's maybe some fun off-track, but the racing is not that. And so we've got a lot of work to do if we're going to be in that space. How do we do it? What's the look and feel of the car?

"So we're building kind of a mule car, so to speak, and we'll beat it up a little bit, see what we can learn. But we're also going to be looking at hydrogen space, alternative fuels, all kinds of things because we've got to be on the forefront of that and not just put all our eggs in one basket."

NASCAR has not seen a new manufacturer enter the sport since Toyota joined the NASCAR Craftsman Truck Series in 2004, eventually leaping to Cup in 2007. Talks with Dodge, one of NASCAR's suitors, are believed to have stalled recently.

"I think there's certainly interest," O'Donnell said. "We are having conversations right now with an OEM, so I'd like to say likely, but it's tough… But again, when you go back to looking at how soon is electrification going to come? Or where do you want to be? And at the end of the day, for us, it's great if you want to be in the electric space, but we want to be entertaining, right? We're a sport. We want to make sure our fans come out there and love what they see, and we've got to balance that."

Reports of leaked documents referring to electric NASCAR plans first surfaced towards the end of last year. They suggested that electric NASCAR racers will run on a 900-volt architecture and have in excess of 1,000 horsepower thanks to a trio of electric motors – presumably in all-wheel drive configuration.

The current Next Gen racecars were designed with the transition to a hybrid system in mind, with the rear transaxle conceived to accommodate an electric motor. There would be no need to change the current brakes or suspension.

Initial thoughts were that hybrids could be introduced for 2024, with he Garage 56 entry at this year's Le Mans 24 Hours establishing some of the groundwork for the system. However, the hybrid has now been dropped from the Le Mans package in a bid to save weight. RT

BELOW NASCAR is investigating running EV support races

Getty Images/NASCAR

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RIGHT IndyCar's hybrid system is to be paired with its existing 2.2-litre engines

IndyCar jettisons new engines to save race to electrification

INDYCAR and its manufacturers are to abandon the development of the new 2.4-litre engine. The decision will cut development costs and safeguard the introduction of hybrid technology in 2024, albeit paired with the existing 2.2-litre twin-turbocharged V6 engines.

The news was swiftly followed by the revelation that MAHLE Powertrain has spent the last two years developing the 'innovative first-of-its-kind' push-to-pass hybrid system for IndyCar. The system is rumoured to be supercapacitor-based. However, its development has been plagued by the wider supply chain issues.

The NTT IndyCar Series remains committed to a more sustainable pathway. It is forging ahead with the introduction of Shell's 100% renewable fuel this season, will continue experiments with Firestone Firehawk tyres containing guayule natural rubber, and teams' transporters will run on 100% renewable diesel.

However, the introduction of hybrid technology is viewed as the big-ticket item by Honda and Chevrolet, with both committed to current or future hybrid and full-electric road cars.

It is understood that the cost of developing new internal combustion engines, coupled with a new and unanticipated need to help the series redevelop and mass-produce the ERS units, left both brands with an uncomfortable choice to make between the two routes. They opted to commit their budgets to electrification, sacrificing the new engines.

"We are most proud of the many advancements that the NTT IndyCar Series has made in leading the motorsports world toward a more sustainable future," IndyCar President Jay Frye said. "The 2.2-litre IndyCar engines supplied by Honda and Chevrolet have provided the most competitive racing in the world. The 2024 hybrid engine package will provide even more excitement with horsepower increases over the current engine."

Developed for production

Honda Performance Development had conducted the first test of its 2.4-litre V6 with an ERS unit installed at the end of October. Chevrolet had not moved its hybrid engine package into a track-testing phase.

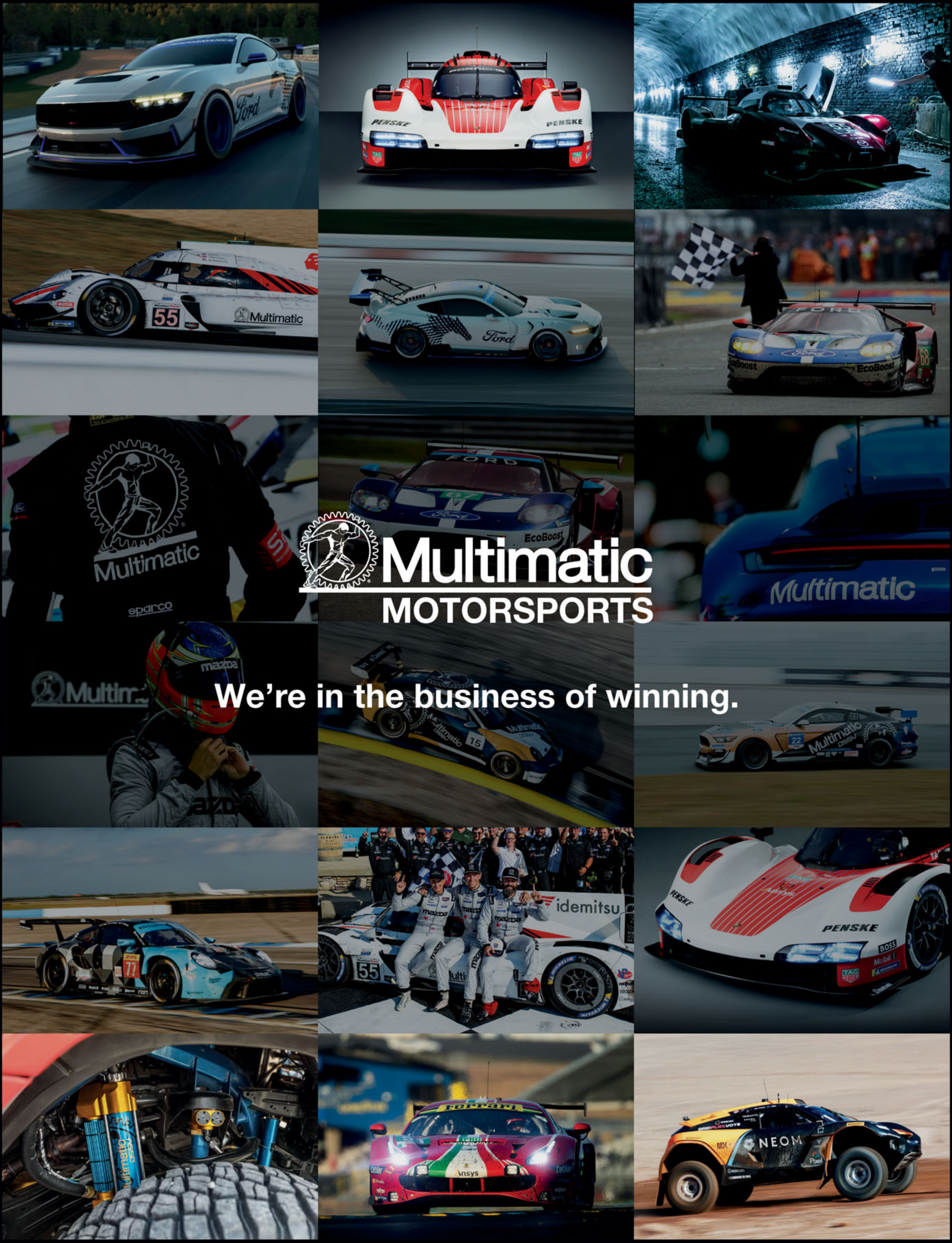
"There has been good progress made on IndyCar's hybrid system. We have covered several race distances to date in the prototype phase," said Honda Performance Development President David Salters. "It now needs to be further developed for production and our teams.

"We are excited to be working and collaborating with IndyCar, Chevrolet and Ilmor on this. To do this in the current timeframe of development, we will keep the current race engine and focus our priorities and resources on collaborating on the new IndyCar hybrid system.

"Focusing on electrification and sustainability is certainly one of our key goals; our engineers and technicians are very motivated to work together and help move the hybrid system onto this next phase. We all have a lot to learn, but that's exactly why we go racing: we actively search out the next challenge.

"The race car environment is extremely challenging. Typically, we strive to make things too small, too light and too powerful, then we make it work! That's part of our DNA, we have learnt how to excel at this challenge. We are excited to assist IndyCar with this challenge, along with Chevrolet and Ilmor, as we push forward to this new electrified hybrid era."

The failure to lure a third manufacturer into the IndyCar fold probably contributed to the decision. HPD and Chevrolet both carry a heavy burden in terms of the number of teams they supply, so the decision of whether or not to retire the existing engine pool had become a pressing one. RT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AVL RACETECH reveals customer H2 ICE with intelligent water injection

AVL RACETECH, the motorsport department of AVL, has built the prototype of an innovative H2 internal combustion engine. The power unit is a compact, hydrogen-powered 2-litre turbo engine, with intelligent water injection that enables it to achieve a totally new performance level.

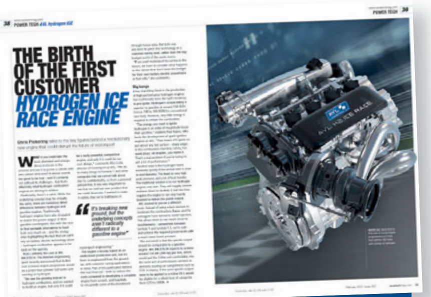
Unlike other H2 internal combustion engines, which are usually operated with a high level of excess air (lean-burn), meaning that they generate comparatively less performance, AVL RACETECH's new racing engine with only slight lean-burn can generate a performance level of around 150 kW per litre. This puts the hydrogen-powered 2-litre turbo engine in the same range as the close-to-production racing classes of today.

Complex challenge

To achieve this high specific performance, AVL RACETECH transferred the principle of water injection to the hydrogen engine. An injector shoots additional water into the intake air of the engine, which increases the boost pressure. In addition, the evaporating liquid has a strong cooling effect in the combustion chamber.

Designing the necessary injectors and valves requires precise knowledge of the overall system behaviour with all air, fuel, and exhaust gas flows – for which AVL uses its tried and tested simulation models and 3D flow calculations. This also ensures that the mechanical limits of the engine are not exceeded and the high safety standards in motorsport are met.

Project Manager Paul Kapus, Manager Development Spark Ignited Engines & Concept Cars, said: "Realizing performance values at motorsport level with a hydrogen internal combustion engine is an incredibly complex technical challenge. But our prototype proves it can be done.


THE BIRTH OF THE FIRST CUSTOMER HYDROGEN ICE RACE ENGINE

AVL'S H2 ICE
See Page 38

"The basic technology of a gasoline engine and a hydrogen combustion engine is very similar – in contrast with fuel cell technology. Which is why our concept is also a very good fit for the economical approach of customer racing, since the adaptations required are very straightforward."

First engine

Ellen Lohr, Director Motorsport AVL, commented: "We are forerunners in many aspects of motorsport with AVL RACETECH and have now made the decision to become leaders in the area of hydrogen combustion engines as well. Which is why we are building our own racing engine for the first time in the more than 20-year history of the AVL motorsport department. We expect to be able to present this hydrogen engine in spring 2023 and are confident that hydrogen combustion technology will play a significant role in achieving a zero carbon future in motorsport."

AVL RACETECH, formerly known as AVL RACING, is the specialist global motorsport division of AVL and has been actively involved in all technical areas of the sport for over 20 years. AVL RACETECH works with customers in more than 17 racing series around the world, in the fields of engineering, testing, simulation and manufacturing. It is a supplier for teams in race series ranging from Formula 1 and NASCAR to MotoGP. RT

LEFT The company ramped up its hydrogen capabilities recently when it opened its Hydrogen and Fuel Cell Test Center at its Graz HQ, with a capacity for 20 high-performance testbeds

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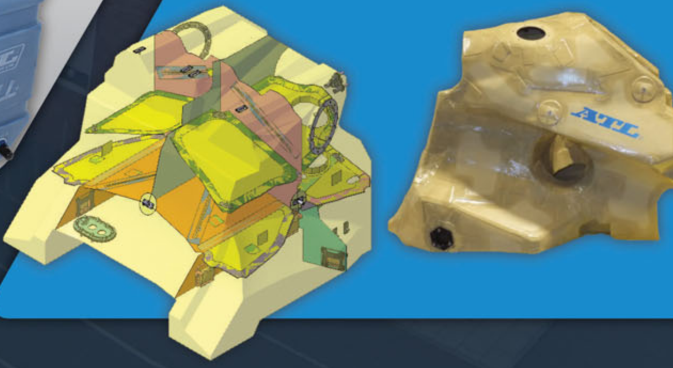

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ABOVE Bcomp's sustainable fibre composites are used extensively on the SF23

Super Formula's new era to feature hybrid flax and carbon fibre bodywork

SWISS lightweighting specialist Bcomp and Super Formula have confirmed their collaboration for the new era of Japan's premier single-seater race series. Following successful testing of Bcomp's flax fibre composites throughout last year, Super Formula has confirmed the innovative bodywork parts will appear on the new SF23 chassis.

The announcement was made on the 50th anniversary of the championship, as Super Formula looks ahead to its future and is undertaking significant steps to target carbon neutrality. With its Next 50 plan, it has specified measures such as the use of new tyre compounds with recycled rubber and natural compounding agents in addition to the use of more sustainable materials in the race cars' construction.

Carbon fibre bodywork is used extensively throughout the motorsport industry and is responsible for a substantial carbon footprint. Many of the carbon fibre parts used in racing end up in landfill when damaged in a race or no longer needed. Bcomp's innovative ampliTex and powerRibs composite technologies are made from flax fibre and offer a promising solution. They have already extensively proven their performance across the board in motorsports series from F1 to Formula E, Extreme E, DTM and GT4 on Porsche, Mercedes Benz-AMG and BMW M GT cars.

With low density and excellent mechanical properties, flax fibres are a significantly more sustainable option for developing high-performance composites. The unique combination of ampliTex flax fabrics with the patented powerRibs reinforcement grid allows this natural fibre composite solution to match the low weight and high stiffness of carbon fibre bodywork parts in a drastically more sustainable package.

Analysis conducted in past projects showed that Bcomp's high-performance natural fibre composites enable a reduction of 90% in material CO2 emissions when compared to carbon fibre parts as well as an over 80% reduction of CO2 emissions from cradle-to-gate, considering all production steps from raw material to the final part.

Additionally, flax fibre-based composites come with a viable end-of-life solution that eliminates the need to landfill damaged or old bodywork.

Extensive testing was conducted in 2022 by Super Formula drivers to evaluate the new engines, fuels, tyres and the Bcomp bodywork. Sidepods and engine covers, entirely made from ampliTex and powerRibs performed well in the initial tests but it seemed more appropriate to create hybrid parts for the implementation in the SF23. A construction with about 70% flax and only 30% carbon fibre for local reinforcements proved to be an ideal combination of each material's benefits while still significantly reducing the carbon footprint.

This innovative collaboration has been recognised already across the motorsport community, including most recently being nominated as a finalist for Race Tech's William Kimberley Green Tech Award.

Johann Wacht, Manager Motorsports and Supercars at Bcomp, said: "Super Formula is considered the second fastest racing series in the world and proves that sustainable technologies are ready to compete at the very highest performance level. The series impressively shows to the industry what is possible, and we are very much looking forward to a great season full of entertainment and sustainable innovations!" RT

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LEFT The 'Haru Oni' pilot plant is the 'poster boy' of synthetic fuel production

eFuels pilot plant in Chile officially opened

PORSCHE and international partners working with the Chilean operating company Highly Innovative Fuels (HIF) have started the industrial production of synthetic fuels.

In the presence of Chilean Energy Minister Diego Pardow, the 'Haru Oni' pilot plant in Punta Arenas (Chile) was officially opened last month. Porsche Executive Board members Barbara Frenkel and Michael Steiner performed the ceremonial fuelling of a Porsche 911 with the first synthetic fuel produced at the site. eFuels made from water and carbon dioxide using wind energy enable the nearly CO2-neutral operation of petrol engines.

"Porsche is committed to a double-e path: e-mobility and eFuels as a complementary technology. Using eFuels reduces CO2 emissions. Looking at the entire traffic sector, the industrial production of synthetic fuels should keep being pushed forward worldwide. With the eFuels pilot plant, Porsche is playing a leading role in this development," said Barbara Frenkel, Member of the Executive Board for Procurement at Porsche AG.

"The potential of eFuels is huge. There are currently more than 1.3 billion vehicles with combustion engines worldwide. Many of these will be on the roads for decades to come, and eFuels offer the owners of existing cars a nearly carbon-neutral alternative. As the manufacturer of high-performance, efficient engines, Porsche has a wide range of know-how in the field of fuels," added Michael Steiner, Member of the Executive Board for Development and Research at Porsche AG.

In the pilot phase, eFuel production of around 130,000 litres per year is planned. Initially the fuel is to be used in lighthouse projects such as the Porsche Mobil 1 Supercup and at Porsche Experience Centers. After the pilot phase, the first scaling will take the project in Chile up to a projected 55 million litres per year by the middle of the decade. Around two years later the capacity is expected to be 550 million litres.

The south of Chile offers ideal conditions for the production of eFuels, with the wind blowing for around 270 days a year and enabling the wind turbines to operate at full capacity. Punta Arenas is also located close to the Strait of Magellan. From the port of Cabo Negro, the synthetic eFuel can be transported just like traditional fuels all over the world, and be distributed using the existing infrastructure.

Porsche is working towards a CO2-neutral balance sheet across the entire value chain by 2030. This also includes a CO2-neutral usage phase for future all-electric models. Synthetic fuels supplement electromobility and are part of the sports car manufacturer's sustainability strategy.

Porsche has already invested over 100 million USD in the development and production of eFuels. For example, it invested 75 million USD in HIF Global LLC in April 2022. This company plans, builds and operates eFuel plants in Chile, USA and Australia. RT

Landmark anniversary for HB Bearings

HB BEARINGS, a leading UK manufacturer of bespoke bearings for motorsport, has celebrated its 50th anniversary.

HB's bearings are used at the highest level of motorsport and are designed to deal with high levels of performance.

'The company's aim is to supply quality bearings in a manner to satisfy the fast moving and ever-changing motorsport industry,' it said in a statement. 'HB Bearings has gained a global reputation for leading the field in innovation, lead times and bearing quality. We are so proud to be associated with major race teams and transmission manufacturers, both in the UK and worldwide.'

Since its inception in 1972, the company has built up a talented team of engineers and designers. The design stage of a bearing is absolutely crucial and with its in-house technical department, and solid modelling CAD system, HB has the knowledge and the experience to assist in the process. Dynamic and static load ratings can be calculated to ISO standards, which can be used to calculate bearing life.

As well as manufacturing bespoke bearings for current race teams, it manufactures for the classic motorsport, motorcycle and historic racing car sectors, exploiting its ability to reverse engineer bearings from drawings, references and samples. RT

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Audi to use ‘reFuels’ on Dakar

AUDI’S RS Q e-tron is to use renewable fuel in this year’s Dakar Rally.

The desert prototypes, which won the Race Tech Race Powertrain of the Year award at last month’s World Motorsport Symposium, utilise electric drive with an energy converter. The latter, based on the manufacturer’s record-breaking DTM engine, will now use an innovative fuel.

“At Audi, we are pursuing a consistent strategy of decarbonization,” said Oliver Hoffmann, Board Member for Technical Development at Audi. “Our battery vehicles and renewable electricity are the lead technologies. To complement this, renewable fuels offer the possibility of running internal combustion engines in a more climate-friendly way. The Audi RS Q e-tron combines both systems in its innovative drive. As a result, we are now even more sustainable on the road in the toughest motorsport imaginable for electric drives.”

To further reduce carbon dioxide emissions, Audi relies on residue-based products that do not compete with foodstuffs for the fuel used in the rally car. Behind this is a process that converts biomass into ethanol in a first step. The final fuel is then produced in further process steps. The process is abbreviated to ethanol-to-gasoline (ETG). The process engineers use biogenic plant parts as the starting product.

The tank content of the RS Q e-tron consists of 80 percent sustainable components, including ETG and e-methanol. This fuel is required by the energy converter, whose combustion engine part operates with high compression and thus very efficiently to supply electricity for the electric drive. So while the drive concept in principle already requires less fuel than conventional systems, there is now a further optimization.

“With this fuel mixture, the Audi RS Q e-tron saves more than 60 percent in carbon dioxide emissions,” says Dr Fabian Titus, Application and Thermodynamics Development.

This development, driven by Audi, complies with the strict chemical specifications of the FIA and ASO fuel regulations. They are similar to the regulations for commercially available fuel grades with 102 octane. Such a high value guarantees the anti-knock properties of the fuel-air mix during the combustion process. With this innovative fuel, the combustion engine even achieves slightly higher efficiency than with fossil-based gasoline. However, the oxygen content in the reFuel reduces the energy density of the fuel, which is why the volumetric calorific value drops. The RS Q e-tron therefore requires a larger tank volume.

Audi’s vision is to drive the world’s most demanding races with 100 percent renewable fuel. A significantly improved CO2 balance will be achieved through the direct use of renewable fuels in HEV (Hybrid Electric Vehicles) models such as the RS Q e-tron and in highly efficient hybrid vehicles for road traffic in general. RT

BELOW Audi will achieve a 60% reduction in GHG emissions through the use of its ‘reFuels’

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Audi already has 220 people working flat-out on its F1 project

ABOVE Audi's recruitment drive for its F1 entry is in full swing

AUDI is ramping up its efforts to hit the ground running when it enters Formula 1 in 2026.

Construction work began before Christmas on an extension to its engine facility. It is not only the infrastructure that is being expanded in Neuburg. The team is also growing steadily. Currently, around 220 employees have been recruited for the F1 project, with the goal being to have more than 300 employees by mid-2023.

A new building, measuring around 3,000 square metres, is underway at the Competence Center Motorsport at the Audi Neuburg facility. New test benches for the development of the power unit will also be installed.

The Competence Center Motorsport, which opened in the summer of 2014, is already considered as one of the most modern of its kind. All of the factory racing operations, as well as customer racing, are coordinated from here. The futuristic Audi RS Q e-tron, with its innovative drivetrain for the Dakar Rally, was built in Neuburg an der Donau, as was also the case for versions of the Audi R18 e-tron quattro hybrid racing car, the Audi RS 5 DTM and the all-electric Formula E racing car.

The entire power unit for the new Formula 1 project, which consists of an energy recovery system, electric motor, battery, highly efficient combustion engine and transmission, is being developed and built in Neuburg. Around 50% of the drivetrain's power will be electric.

"With the Competence Center Motorsport, we have an ideal base for our Formula 1 project," said Oliver Hoffmann, Board Member for Technical Development. "Audi Neuburg was designed from the outset to be able to tackle the most demanding motorsport projects. This foresight is paying off. With the existing facilities, we were able to immediately begin with the Formula 1 project.

"The expansion will create the necessary infrastructure for the development of our F1 power unit for the long term. With the building extension and the installation of state-of-the-art test benches, we are giving our development team the best possible conditions to be successful in the top class of motorsport."

The new building, called F7.2, will be built at the south-western end of the existing complex on a previously unused area and will be connected to the F7 building through a closed bridge. In addition to test benches for the power unit and engines, there will be technical rooms, a mechanical workshop and workplaces for about 60 employees on a total area of 3,000 square metres. Completion of the extension is planned for the first quarter of 2024. Part of the new building is to be put into operation as early as this March.

The electricity and heat supply in Neuburg is already CO2-neutral: the facility is supplied with district heating from industrial waste heat and green electricity from hydroelectric power plants. The FIA (Fédération Internationale de l'Automobile) has awarded the facility its highest accolade for environmental conservation and sustainability with the three-star environmental seal of approval. Audi's goal is to generate the energy for the Formula 1 project at the Neuburg facility completely independently and regeneratively in the medium term.

"Developing a power unit for the world's most demanding racing series in Germany is a great challenge," said Adam Baker, Managing Director of Audi Formula Racing GmbH, which was founded for the project. "We already have a great team at our facility in Neuburg an der Donau that is growing all of the time."

Audi has also welcomed the arrival of Andreas Seidl to its F1 partner team, Sauber, as Chief Executive Officer. The move marks Seidl's return to Hinwil for the first time since the BMW and BMW Sauber F1 Team era between 2000 and 2009.

Seidl also has previous experience working within the Volkswagen brand during his time as Team Principal of the Porsche WEC squad in the FIA World Endurance Championship.

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SUSTAIN
BY CORYTON

ABOVE & LEFT The 1,000-mile run highlighted the potential of fossil-fuel-free sustainable petrol

Sustainable fuel “a real and credible player”

A COMPLETELY production standard 184 ps 2.0-litre Mazda MX-5 Roadster has established a benchmark lap time for a zero fossil fuel sustainable-fuelled car at a racetrack in each of the UK home nations.

Powered by SUSTAIN 100% sustainable road fuel from Coryton, the unmodified Mazda MX-5 completed laps at Anglesey Circuit in Wales, Oulton Park in England, Knockhill in Scotland and Kirkistown in Northern Ireland across a week in which the car also drove 1,000-miles around the UK from circuit to circuit on sustainable petrol.

The second generation Coryton fuel was created using 100% agricultural waste, such as straw, by-products and waste from crops which wouldn’t be used for consumption. Underlining the role sustainable fuels can play in de-carbonising both road cars and motorsport, the drive also highlights how sustainable fuels could complement Mazda’s Multi-Solution approach to achieving climate neutrality.

Mazda is investing in different projects and partnerships to promote the development and use of renewable fuels in cars. In Japan, it is involved in several joint research projects and studies as part of an ongoing industry-academia-government collaboration to promote the widespread adoption of biofuels from microalgae growth. In Europe, Mazda was the first OEM to join the eFuel Alliance.

The completely unmodified MX-5’s performance, economy and engine character was unchanged by the SUSTAIN 100% road fuel supplied by Coryton; in fact, excluding the circuit laps the MX-5 averaged 45.6 mpg.

David Richardson, director at Coryton, said: “This project combined a great car with sustainable fuel to lower more than just lap times. As this challenge has shown, sustainable fuel is a real and credible player in our efforts towards net zero.

“Drop-in sustainable fuels are ready now for everyday road cars with internal combustion engines. The UK alone currently has 36 million combustion engine cars on the roads that we could be reducing the emissions from right now. The product and technology is ready to go – the industry just needs support to help scale up operations.” RT

Honda Civic Type R to be built for TCR

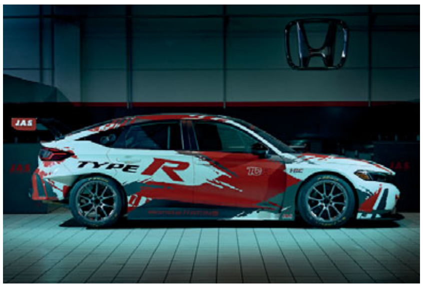
HONDA has given its blessing for the latest version of the Honda Civic Type R to be built as a TCR model from 2023.

The new Honda Civic Type R TCR, which is based on the FL5 production model first released last year, has been developed by Honda’s long-standing motorsport partner, JAS Motorsport.

Key features of the new Civic Type R TCR include an all-new exterior design and aerodynamic package, a new chassis, upgraded braking and transmission systems as well as a race-refined version of the four-cylinder, two-litre turbocharged engine featured in the production version of the car.

An ‘endurance’ version will also be available for customers planning to contest long-distance events.

Development of the car underlines both Honda’s long-standing commitment to customer racing and the strength of the relationship between itself and JAS Motorsport.



ABOVE The new Civic Type R TCR joins the current list of 25 models and more than 1,100 cars eligible for TCR competition globally

Honda Racing driver Néstor Girolami, who finished runner-up in the 2022 WTCR – FIA World Touring Car Cup for ALL-INKL.COM Münnich Motorsport, gave the car its maiden run at the Circuit Tazio Nuvolari in Italy before Christmas.

The new car continues a long and successful partnership between Honda and JAS Motorsport that began in 1998 and intensified when the Milan-based organisation was chosen to develop the first Civic Type R for grassroots circuit racing and rallying in 2001.

Since then, JAS-developed Civics have helped Honda to become FIA World Touring Car champions in 2013 and its partner teams to achieve 398 TCR race victories and 74 major crowns in the category globally. RT

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‘Attack Charge’ introduced for Gen3 era

FAST-charging technology is to be introduced to Formula E later this season, once the reliability of the new Gen3 cars is proven.

The technology will allow for the introduction of ‘Attack Charge’ at selected E-Prix. Attack Charge will take the form of a mandatory mid-race 30-second pit-stop, made possible by a 600-kW booster. This will then unlock two ‘Attack Mode’ periods, during which the power output of the all-electric single-seaters will increase from 300 kW to 350 kW.

In the meantime, the existing format of two standard Attack Modes per E-Prix – providing drivers with a temporary power boost – will remain in place, with competitors now able to choose their activation strategy in an effort to maximise wheel-to-wheel racing and overtaking opportunities.

The roll-out of the new Attack mode has been delayed by initial problems with the standard supply battery packs. Formula E insists these issues are now fixed, with the initial group test of the new Gen3 race car now having concluded.

The Gen3 will make its competitive debut in the 2023 Hankook Mexico City E-Prix on 14 January, the opening race of Season 9.

Through five days of testing in Valencia, drivers completed a combined total of 5,128 laps, clocking up more than 17,300 km. On the final day of testing, the top five drivers all went half-a-second quicker than the best time previously recorded by the Gen2 car. Maserati MSG Racing’s Maximilian Guenther set a Formula E testing lap record of 1:25.127.

Drivers from teams including TAG Heuer Porsche Formula E Team, Maserati MSG Racing, NEOM McLaren Formula E Team and TCS Jaguar Racing were testing the Gen3 on track together for the first and only time before the Mexico City event.

A smaller, lighter chassis and an additional front powertrain adding 250 kW to the 350 kW at the rear are among the many technological developments of the Gen3 race car, which is capable of a top speed of 200 mph/322 kph.

“It’s a massive step forward in terms of power and it’s lighter and those two things you always look forward to as a driver – more power and less weight,” commented António Félix da Costa, of the TAG Heuer Porsche team. “There’s a front powertrain too now and it’s going to be a highly efficient car – 40% of the total energy used in a race will be from regen. It’s a big step in technology.

“They have a lot more power than before and at the moment, in certain conditions, it’s quite hard to use it which is a good thing for the people watching. There will be more mistakes from the drivers and it will be harder to dominate in this car right now – I think it will produce very good racing.”

“There’s a lot to discover,” said Edoardo Mortara, Maserati MSG Racing. “We were at the maximum with the Gen2 car last year with software that was exploiting the entire performance available after years of working with those cars and powertrains. We’ve got a lot to learn and there’s a lot more to come.”

“The Gen3 offers different challenges with regen on the front axle now and 600 kW total front and rear,” said Maserati team-mate Maximilian Guenther. “The braking feel is different and even more variables can be controlled on the software side together with your engineers – the possibilities of this is pretty exciting.

“The car will be fast on the streets because you have a lot more power – 100 kilowatts more, up from 250 kW in Gen2 – and we’ve got different tyres with different characteristics to the previous ones. All in all it’s a great challenge and the car looks very aggressive.” RT

BELOW The Gen3 cars will enable a strategy shake-up

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Greenland Extreme E: "a race without a trace"

EXTREME E has revisited its Legacy Programme in Greenland, where last year it became the first international sport to race at the base of the world's second largest ice sheet.

Laust Logstrup, Kangerlussaq Town Mayor, said: "Where the race site was located, the sand has been blowing over the area and there are flowers where the camp was situated. You cannot see that there had been a race taking place there last year. This is certainly a race without a trace."

When it comes to the climate crisis, few places have felt the impact quite like Greenland. The melting of its ice sheet presents the single greatest threat to sustainable sea levels, with many scientists predicting that a complete melting of the one-million-year-old ice cap could lead to a seven-metre sea level rise over the next 350 years.

In step with this stark reality, Extreme E endeavoured to radically minimise the environmental impact of the Arctic X Prix in August 2021. As documented by world-renowned EY's Social and Environmental Impact Design Considerations Report, most impact factors, such as contamination, protected areas and noise, were judged to be a low risk, with none deemed a high risk to Greenland and its environment.

Really shocked

Drivers Kevin Hansen and Hedda Hosås were among the party revisiting the site. "I remember the first time I was in Greenland, I was really shocked, so I can just imagine how it was for Hedda [Hosås] to go for the first time," said JBXE driver Hansen. "It's something that brings back a lot of emotions I think, because it really affected me last time I was in Greenland.

"It's an absolutely beautiful location. To do a race in the region, raise awareness for climate change and the melting ice sheets, and then to come back and see that it's like we were never even there, is amazing.

"I think that's hugely important to remember, that we don't come to these places to make a mess and just do it for good action. We come to these locations to make a difference."

The Legacy Programmes are at the centre of the Extreme E Championship. Set up in each race location, these aim to provide positive support relating to specific local needs. Last year, Extreme E set up a series of projects at the local school in the town of Kangerlussuaq as part of leaving a positive legacy.

These projects included the installation of solar panels outside of the school gates in partnership with XITE ENERGY Racing and myenergi, as well as helping implement climate into the curriculum in Greenlandic so it was accessible to all. The programme was rolled out to 3,600 young people across Greenland.

Ali Russell, Chief Marketing Officer of Extreme E, said: "The reason that we come to places like Greenland is all about legacy. We're using sport for good and it's the catalyst of change." RT

BELOW Kevin Hansen and Hedda Hosås were among the party revisiting the site

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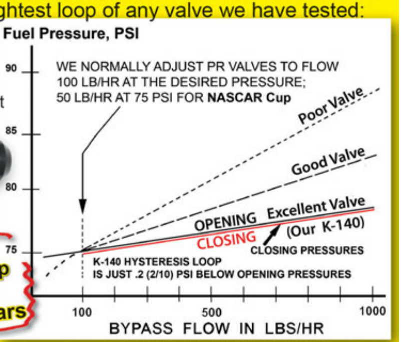

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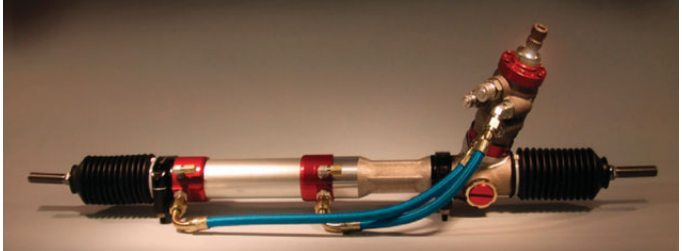

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SUSTAINABLE MOTORSPORT 2030 – FROM RACE TO ROAD

Mark Skewis offers a glimpse behind the scenes at last month's Race Tech World Motorsport Symposium

A **PROBLEM** shared is a problem halved, runs the old adage. If that holds true, a lot of relieved people emerged from last month's Race Tech World Motorsport Symposium.

Back after a two-year hiatus due to the global pandemic, the WMS again underlined its priceless ability to act as a forum for debating the challenges faced and solutions sought by the industry.

The theme for WMS 2022 was 'Sustainable Motorsport 2030 – From Race to Road'. "Racing is the fast track to the adoption of advanced technologies on the road but the path from race to road is only open if knowledge is shared," stressed Formula 1 Chief Technical Officer Pat Symonds, co-chairman of the event with former Audi engine guru Dr Ulrich Baretzky.

"The World Motorsport Symposium provides the ideal forum for open discussion and the dissemination of that knowledge," he continued. "This ensures that technologies that can contribute to subjects such as safety and sustainability become more accessible."

In order to facilitate that exchange of information, the WMS again operated under 'Chatham House' rules whereby: 'Participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed.'

Across the years, this framework has proved a vital part of the Symposium's appeal. "It is the only event in the world of motorsport where you can exchange honest opinions without the threat of being reported in a newspaper and finding yourself called in front of your boss on Monday morning!" suggested Baretzky.

This year's event was hosted by the Embassy for Switzerland, in the heart of London. The venue proved ideal and also very appropriate: Switzerland has just lifted its nearly 70-year ban on motorsport events, dating back to the aftermath of the tragic accident at Le Mans in 1955.

With Audi entering Formula 1 with the Hinwil-based Sauber, Switzerland is very much in the news at the moment. Away from the glare of the spotlight, though, it has long been developing a thriving motorsport ecosystem whose companies are helping shape the future direction of the sport. Many were in attendance both at the WMS and its networking awards dinner, held at the world-famous Mosimann's Club.

CLOCKWISE FROM ABOVE The award winners: pictured together (left); Reaction Engines' Tom Burvill collects the Don Burgoon Most Innovative New Motorsport Product of the Year Award from Mary Ann Burgoon; McMurtry Automotive's Thomas Yates is presented with the Dino Toso Aerodynamicist of the Year Award by Soheila Kimberley; Audi's Stefan Dreyer (Race Powertrain of the Year); TotalEnergies' Romain Aubry (William Kimberley Green Tech Award); and Hannah Schmitz (McLaren Applied Female Engineer of the Year Award, presented by McLaren Applied's Pauline McFerran)

Europe's energy transition

John Cooper, Director General at FuelsEurope and Concawe, set the tone for the event with a fascinating presentation on motorsport's role in Europe's energy transition. The figures he revealed prompted pause for thought, as did his assertion that: "Every internal combustion engine being climate neutral is not a fantasy."

The WMS retained its popular format of presentations interspersed with 'Cabinet' sessions, where panels debated subjects and took questions. The experts discussing sustainable fuels raised the point that, if even a small percentage of the planet's existing ICE infrastructure was to adopt this technology, it would represent a potentially huge impact in the battle against the climate crisis.

With Electric Vehicles such a hot theme, Professor David Greenwood's presentation on battery technology was eagerly-anticipated – and didn't disappoint. He delivered an enlightening assessment, bringing the audience up to speed with the latest advances. Among other things, he raised the issue of whether charge anxiety has begun to replace range ▶

> "Racing is the fast track to the adoption of advanced technologies on the road but the path from race to road is only open if knowledge is shared"
>
> **PAT SYMONDS**, Chief Technical Officer, F1

> *Every internal combustion engine being climate neutral is not a fantasy"*
>
> **JOHN COOPER**, Director General at FuelsEurope and Concawe

anxiety, and highlighted the increasing focus on the end-of-life scenarios for batteries.

With Russia's invasion of Ukraine adding momentum to the move away from oil and gas, the role of hydrogen – which, it didn't escape notice, could be used for heating – was a recurrent theme throughout this Symposium. Enter, stage left, presentations on the Le Mans-organising ACO's sustainable and hydrogen strategy by Bernard Niclot, Head of Hydrogen project at ACO, and Thierry Bouvet, Competition Director, ACO.

Both, of course, have been instrumental in Mission H24's development of a hydrogen fuel cell-powered racing car for a new class that it is firmly believed will one day win the Le Mans 24 Hours. How is it going? Things that just four years ago would have been the domain only of a starry-eyed university thesis are now, they insist, close to becoming a reality.

Harnessing hydrogen was a theme on which both Romain Aubry, TotalEnergies Motorsport Technical Manager, and Jean-Francois Weber, co-founder of GreenGT, would speak with authority. The latter informed us that the H24 prototype was gaining pace

ABOVE Audi's Lea Schwarz suggested, "Machine Learning and Artificial Intelligence will have such a big impact on everything we do"

RACE TECH
WMS
World Motorsport Symposium

RIGHT Ulrich Baretzky pays tribute to Kimberley Media Group founder, and friend, William Kimberley

LEFT The speakers and panellists who led the lively discussions at WMS 2022

every time it ran and that it was shedding hundreds of kilos each year as the fuel cell technology improved.

Such was the calibre of the presentations, that it is hard to do them justice here – especially under Chatham House Rules. Arguably one of the standout moments of the first afternoon was when Andy Cowell, the man who played such a key role in Mercedes' domination of F1's hybrid era, offered his view of F1's 2026 engine regulations.

Was it favourable? There was, perhaps, a noticeably sharp intake of breath from F1 CTO Pat Symonds, who was deeply involved in the conception of the new PU rules, when Cowell took the microphone! And, later, a sigh of relief when the microphone was handed back amongst the din of applause. The verdict? You had to be there, but take it as a thumbs-up.

The opening day concluded with three very powerful speakers. Audi's Lea Schwarz captivated the audience with ▶

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LEFT Andy Cowell, one of the architects of Mercedes' F1 success, said, "I'm going to put my mischievous hat on…" before analysing the 2026 F1 powertrain regulations her insight into the emerging role of AI/machine learning in: 'Motorsport in a changing world – facing sustainability and road relevance', before the architects of this year's aerodynamic upheaval in Formula 1 and NASCAR took over.

Jason Somerville, Head of Aerodynamics, FIA, assessed the success of F1's game-changing efforts to improve the racing. More than 8,000 CFD and wind tunnel runs underpinned the aero team's work, he revealed.

Then Eric Jacuzzi, Managing Director, Aerodynamics/Vehicle Performance, R&D Center, NASCAR, gave an insight into the development of the Next Gen NASCAR, which ushered in the biggest technical shake-up in the history of stock car racing. It was fascinating to hear, throughout both days, Jacuzzi's opinions from a racing culture that is sometimes alien to those involved in its European counterpart.

They might be the giants of the motorsport world, but F1 and NASCAR don't talk to each other as much as you might imagine. Until now…

The second day commenced with some thought-provoking revelations from Larry Holt, Executive Vice President – Multimatic Special Vehicle Operations Group, regarding the manner in which Multimatic's revolutionary DSSV Technology was taken from Race to Road. His message to the rule-writers was to look closely at harnessing the ability to harvest energy from the suspension.

Holt's very presence can often be as disruptive as the technology he handles so well, and his opinions were typically candid, and welcome, throughout the WMS.

Julien Gillard, Head of TGR Simulation UK, Toyota GAZOO Racing Europe, then acknowledged that "simulation came of age in motorsport". In his presentation, 'Sustainability through Simulation', he pointed out that improved simulation can help reduce emissions by saving on the production and testing of mule vehicles in race programmes.

"We do such great things in motorsport but one of our problems is that we don't

RIGHT The co-chairmen, Pat Symonds and Ulrich Baretzky, did a magnificent job, both behind the scenes and in the spotlight

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LEFT NASCAR's Eric Jacuzzi revealed that more than 3,000 CFD runs and 100 wind tunnel runs had helped shape the Next Gen car

LEFT Multimatic's charismatic Larry Holt raises a smile during a panel session

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> *After the sad years of COVID, it was a pleasure to meet the motorsport community again. We share the same passion and are all aware that motorsport has to evolve to green technologies, as we are doing in the ACO with the hydrogen project. These technologies were at the core of all the discussions I had"*
>
> **BERNARD NICLOT**, ACO Mission H24 Innovation Director

usually talk about them," he lamented.

The contributions of Dr Wolfgang Warnecke, Adviser Carbon Management, Shell Germany, were invaluable throughout the event. He took the podium on day two to discuss hydrogen's future role.

He began by acknowledging that there was a lot of confusion about sustainable fuel. When issues of availability, acceptability and affordability appeared to be paramount, he said, the temptation was always for sustainability to take a back seat. He also arguably tackled the question that is often the elephant in the room when he asked whether, if EVs were taking over the road, motorsport really had to go EV too?

Warnecke reported that Shell was "steaming ahead" in dealing with what he referred to as an "energy mosaic". Hydrogen, he said, would come, but it remains difficult to transport and the generation of green electricity we need so badly was predominantly in remote locations at present. Nevertheless, he opined , hydrogen would make its way into the construction and marine sectors, and into long-distance motorsport where battery EVs were not applicable.

A man whose company has been involved in electric motorsport since its very inception, Ruaraidh McDonald- ▶

Walker, Technical Director of McLaren Applied, brought the audience up to speed in his talk on 'What is next for electrified motorsport?' He also noted that the marine industry, where conventional ICE craft increasingly run the risk of being banned, is gradually adopting electrification.

Another well-known industry figure who has a perspective from both sides of the fence, F1 and Formula E, is Techeetah founder Mark Preston. "Colleagues in F1 thought I was nuts," he confessed of his switch to Formula E. "They were convinced we would never be able to manage doing a single lap!"

RIGHT Soheila Kimberley, KMG's Publishing Director, was the lynchpin of the event

BELOW LEFT & RIGHT Three aerodynamicists played an important role in making WMS 2022 such a success: the FIA's Jason Somerville (left), gave a great presentation; John Iley, of Iley Design, was the Speaker and an invaluable part of the organising team; and Sauber's Willem Toet (right), offered intelligent contributions throughout

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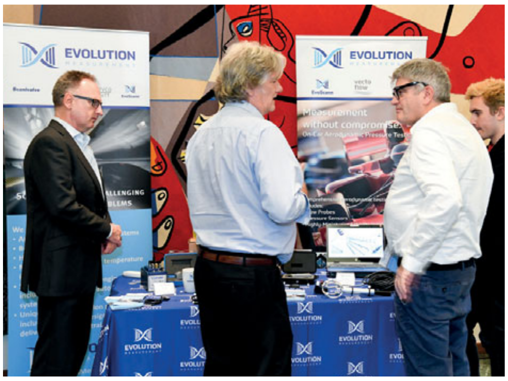

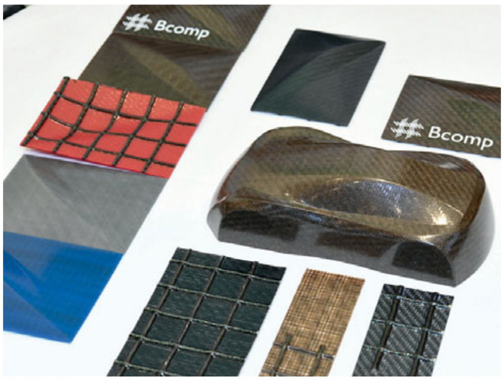
Bcomp
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sharc
periscope

ABOVE Mosimann's Club, one of the world's most prestigious dining clubs, was venue for the WMS technical awards presentation. Mary Ann Burgoon, pictured top left with Soheila Kimberley, presented the Don Burgoon Most Innovative New Product of the Year accolade

LEFT The sponsors' technology, expertise and opinions played an important role

Fast-forward eight seasons and the Gen3 car, the most efficient EV racecar ever built, is with us and ready to tackle issues such as fast-charging.

Proceedings were wrapped up by two presentations focusing on sustainability. Stephane Bazire, Head of Business Sustainability &Partnerships at Silverstone Circuit, and Ellen Jones, Head of Sustainability, Formula 1, were faced with what, in conference terms, is the graveyard shift – but by the end of the sessions there remained, fittingly, a real electricity in the room.

> *"This was my first time attending the World Motorsport Symposium and it was an overwhelmingly positive experience. The quality of people, content and discussions were at the highest levels but the camaraderie amongst those in attendance really stood out. I plan to mark it on my calendar now for 2023 and bring several people from NASCAR to attend. Can't wait"*
>
> **ERIC JACUZZI**, Managing Director, Aerodynamics/Vehicle Performance, R&D Center, NASCAR

Bazire recounted an interesting anecdote about the monitoring of air quality at Silverstone. Records revealed one particular day when emissions were unseasonably high, he said. Upon inspection of the details, it emerged that cranes had been working on a bridge over the racetrack. In one day, they had surpassed the total emissions for the complete British Grand Prix weekend. Now what was that we said about the construction industry needing hydrogen?

Jones, meanwhile, reported that while the move to sustainable fuels by 2026 was an integral part of F1 going Net Zero by 2030, rationalising the logistics challenge of the race calendar was a big-ticket item.

WMS 2022 would not have been possible without the sponsors: Multimatic, McLaren Applied, Bcomp, Evolution Measurement, Allengra Flowmeters and Sharc. Their contribution was immense, not just in terms of the technology they had to share, but for the knowledge and enthusiasm they contributed to all the discussions.

Pushing the envelope

"Overall, this was a Symposium that pushed every corner of the envelope, not just in terms of its presentations but also the opinions offered throughout," concluded Kimberley Media Group Publishing Director Soheila Kimberley. "The scope of the discussion, from sustainable fuels to hydrogen and from Battery Electric Vehicles to hybrids, all against a backdrop of the need to find a sustainable way forward, was remarkable. Everyone seemed to be buzzing!

"On a personal level, it was sometimes painful to deliver the first WMS without William, but everybody's enthusiasm was infectious and I think we all ended up riding that wave.

"I am deeply indebted to the three men whose hard work behind the scenes made this all possible: Ulrich Baretzky, Pat Symonds and John Iley. You are all absolute stars!

"The feedback from this event has been amazing," she continued. "So many attendees have told me that the people they met have opened new avenues for them to explore. We will learn any lessons we need to take on board and come back even better for WMS 2023!" RT

THE BIRTH OF THE FIRST CUSTOMER *HYDROGEN ICE* RACE ENGINE

Chris Pickering talks to the key figures behind a revolutionary new engine that could disrupt the future of motorsport

WHAT if you could take the most abundant and energy-dense molecule in the universe and use it to power a vehicle with zero carbon emissions? It almost sounds too good to be true – and it's certainly not without its challenges – but that's effectively what hydrogen combustion engines are striving to achieve.

Predictably, there's a catch. While the underlying concept may be virtually the same, there are numerous detail differences between hydrogen and gasoline engines. Traditionally, hydrogen engines have also struggled to match the power output of their gasoline counterparts. But with the race to find workable alternatives to fossil fuels very much on – and the energy crisis highlighting the fact that we can't rely on battery electric technology alone – hydrogen combustion appears to be back on the agenda.

That's certainly the case at AVL RACETECH. The Austrian engineering giant recently announced that its first ever in-house engine programme would be a 2-litre four-cylinder GDI turbo unit running on hydrogen.

"We saw the growing interest in hydrogen combustion, and we wanted to build an engine, but only if it could be a really powerful, competitive engine, and only if it could be our own design," comments Ellen Lohr, director of motorsport at AVL. "We do so many things in Formula 1 and other categories that we cannot talk about due to confidentiality, so from a personal perspective, it was very important to me that we had our own product that we could showcase. I wanted to make it visible, that we're trailblazers in motorsport engineering."

> *"It's breaking new ground, but the underlying concepts aren't radically different to a gasoline engine"*

The engine is loosely based on an undisclosed production unit, but it's been re-engineered from the ground up, with customer racing applications in mind. Part of the justification behind this was financial – both to reduce the costs compared to developing a complete engine from scratch, and hopefully to recuperate some of the investment through future sales. But Lohr was also keen to pitch this technology at a customer racing level, rather than the big-budget world of the works teams.

"If we want motorsport to survive in the future, we have to consider what happens to the classes that don't have the budget for their own battery electric powertrains or fuel cells," she comments.

Big bangs

A key stumbling block in the production of high-performance hydrogen engines has traditionally been the fuel's tendency to pre-ignite. Hydrogen's octane rating is superior to gasoline at around 130 RON (versus 100 to 105 RON for conventional race fuel). However, very little energy is required to initiate the combustion.

"The energy you need to ignite hydrogen is an order of magnitude lower than gasoline," explains Paul Kapus, who leads the development of spark ignition engines at AVL. "That means it'll ignite on just about any hot surface – sharp edges in the combustion chamber, valves, hot spark plugs, oil droplets, you name it. That's a real problem if you're trying to get a lot of performance."

Another issue is that hydrogen burns extremely quickly if the air-fuel ratio is close to stoichiometry. This leads to very high peak pressures and a lot of heat transfer. The traditional solution is to run hydrogen engines very lean. They will happily tolerate mixtures down to lambda 3, but this then requires the engine to run very heavily boosted to restore the power output.

AVL wanted to pursue a different route. Instead of using a lean mixture to moderate the combustion, Kapus and his colleagues have turned to water injection. This allows them to run much closer to stoichiometry – somewhere between lambda 1 and lambda 1.5, we're told – and achieve the required power levels with a much lower boost pressure.

The end result is that the specific output should be comparable to a gasoline engine. AVL RACETECH expects to achieve around 150 kW (200 hp) per litre, which would put the 2-litre unit comfortably into the same sort of performance window as domestic touring car competitions such as TCR. In theory, if the same specific output were to be applied to a 4-litre V8, it would be eligible for a whole host of categories from GT3 to LMDh. ▶

AVL RACETECH
AVL H2 ICE RACE

ABOVE AVL RACETECH'S first ever in-house engine programme is a 2-litre four-cylinder GDI turbo unit running on hydrogen

AVL
RACETECH
H_2

ABOVE Extracting motorsport performance levels from a hydrogen ICE is an incredibly complex challenge

Injection technology

Kapus says the biggest technical challenge in the project so far has been getting the hydrogen into the engine. Because the gas ignites so easily, there's a real danger of backfiring if a port injection system is used.

"You only need one hot particle to come back from the exhaust during the valve overlap period and it will ignite the incoming charge," he notes. "The burnt fuel needs to be scavenged from the cylinder as effectively as possible to prevent any hot residual gas igniting the incoming charge."

AVL has gone with a direct injection setup, which is thought to have greatly reduced this risk.

However, it still poses challenges. Hydrogen has no lubricating properties, which means that the injectors are effectively running dry. The engineers also have to deal with a phenomenon known as hydrogen embrittlement, where the gas diffuses into metals – including, potentially, the materials used in the injectors – causing them to weaken. Add elevated temperatures into the equation and it becomes a particularly challenging environment.

"Our current hardware would certainly be okay for one race, but beyond that it's harder to say. You can compensate in software to a certain extent [a bit like the approach used to compensate for injector drift] but the injector suppliers are already working on solutions. For now, we want to use the current technology to get started on the engine development," comments Kapus.

There are other challenges to negotiate. As with a conventional gasoline engine, hydrogen burns within a quenching zone, which separates the flame front from the unburnt gas and the cylinder walls beyond. In a hydrogen engine, however, this quenching ▸

> *AVL's water injection system helps to moderate the in-cylinder temperatures and reduce the heat rejection"*

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zone is very thin, which means the fuel burns closer to the cylinder walls. This, combined with the rapid burn speeds, means that more heat is transferred to the cylinder walls. AVL's water injection system helps to moderate the in-cylinder temperatures and reduce the heat rejection, but the cooling system still needs to be adequate for the job.

"The water injection reduces temperatures, which serves two purposes," explains Kapus. "Firstly, it prevents local pre-ignition that you might otherwise get with hot spots. And secondly, it avoids the extremely high heat transfer coefficients that we'd have otherwise. As a result, if you have a good cooling system, you can use reasonably standard materials, without having to resort to anything too exotic. The better the cooling is on the base engine, the less you will need to modify it."

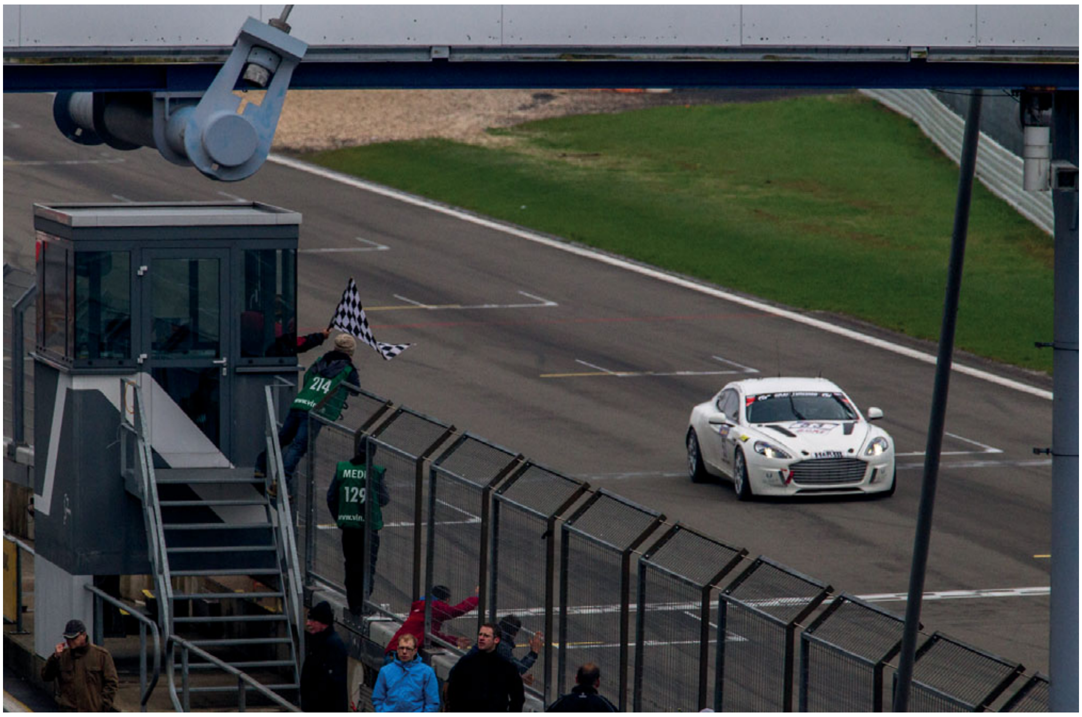
> *"Burnt fuel needs to be scavenged from the cylinder as effectively as possible to prevent any hot residual gas igniting the incoming charge"*

The modifications to the road-going base engine that AVL has chosen largely focus on the top end, the cooling system and the turbocharger. The pistons have been modified and we're told careful attention was also paid to the valve, valve seat and piston ring materials. For safety reasons, Kapus points out, plastic intake manifolds should be avoided. Blow-by can be an issue too, especially when using water injection. Again, this is something that can be managed, but it's important that the pressure build up in the crankcase is relieved.

So now you've got a spark ignition engine with the right cooling and durability considerations, you can just change the injectors and run on hydrogen? Not exactly. The next thing to consider is the turbocharger, which will need to be matched specifically to the hydrogen-burning version of the engine. All being well, the shape of the resulting torque curve should be relatively similar to that of the base gasoline engine, but the size of the power band and the engine's sensitivity to other factors such as altitude will depend on how well it's matched to the turbocharger.

"The leaner you go, the harder it gets," notes Kapus. "Eventually, matching between compressor and the turbine really gets difficult; the less lean you have to run, the easier it gets."

And once you've got the air and fuel into the cylinder, the next job is to ignite the mixture. We're told that a standard gasoline ignition system won't work, so AVL has used a specific one for hydrogen, which is understood to be substantially different. There are no further details at the moment, but given the required energy is relatively low, we'd assume that the challenge is principally focused on controlling how and when the fuel is ignited – including, perhaps, reducing the risk of pre-ignition from residual heat. ▶



ABOVE Bound so often by confidentiality clauses, Director of Motorsport Ellen Lohr believed it was important for the company to look after the entire project

LEFT AVL gained experience with hydrogen in a previous project with the Aston Martin Rapide S that lapped the Nürburgring back in 2013

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Practical considerations

AVL RACETECH has concluded its simulation work on the engine and is about to begin building its first physical prototype. It's hoped that this will be running in the spring of 2023. There will be additional challenges involved in installing it in a racecar, but these are already well-documented.

"This is the first time we've done a competition engine, but we have already built a hydrogen racing car some years ago," comments Kapus. "There are things that you need to watch. For instance, hydrogen will ignite quite easily and in very low concentrations so you need hydrogen sensors and shut-off valves. You need to be careful with the hydrogen concentration around the crankcase, the intake manifold, the tanks and the cabin. But none of this is magic, it's all quite easy to achieve with modern technology."

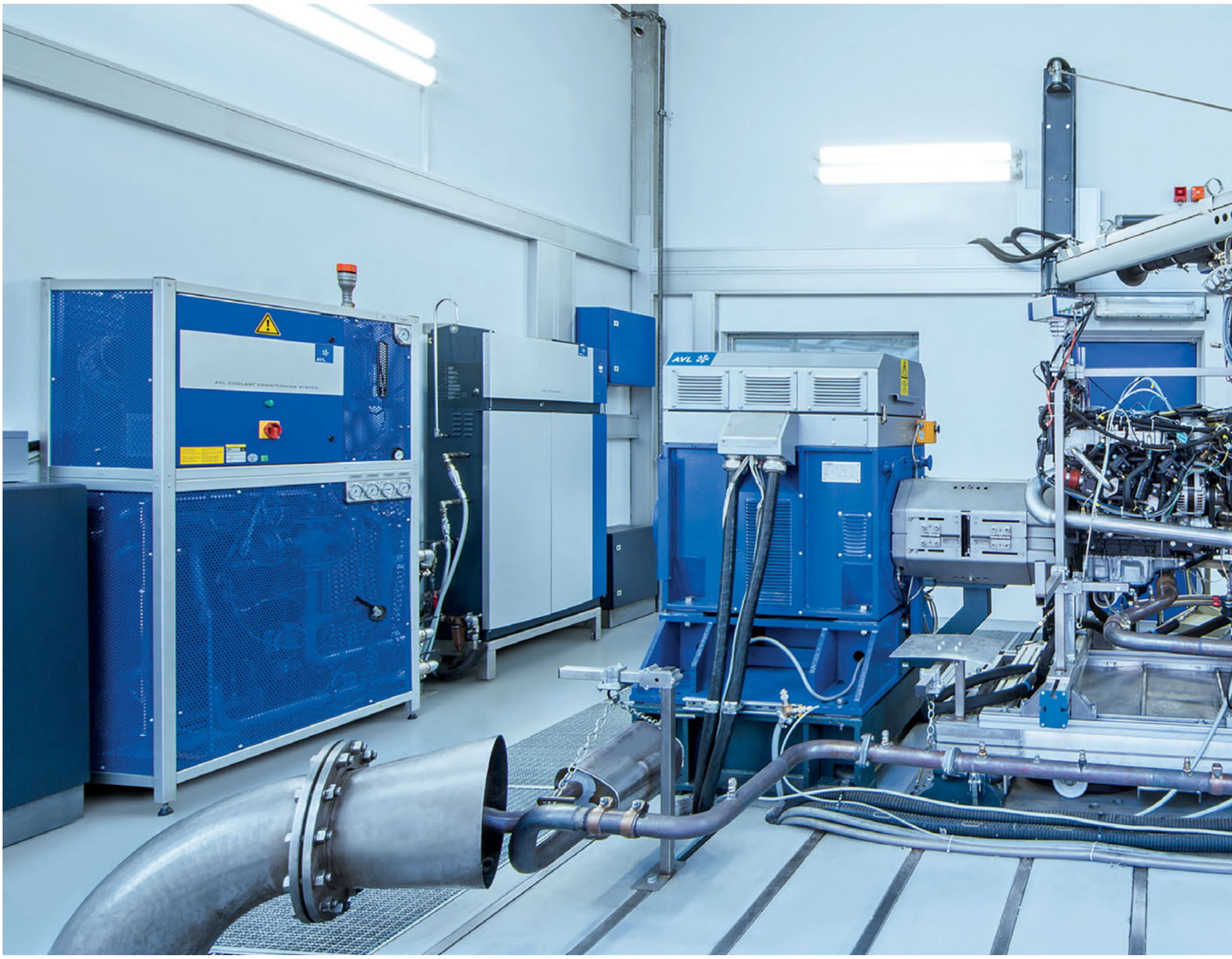
Another practical issue when moving from the test bench to the racecar will be fuel storage. Relative to its mass, hydrogen has around 2.8 times the energy density of gasoline, but the tanks required to store the pressurised gas are comparatively large and heavy, which puts a practical limit on how much can be stored at present. To compound matters, the thermal efficiency of hydrogen engines also tends to be somewhat lower at equal air/fuel ratio than gasoline due to the increased heat rejection, which increases their fuel consumption. (Although when gasoline is run rich, the efficiency of hydrogen – running at least a bit lean – will be higher.)

However, AVL believes that something a bit better than with a gasoline car should be realistic, with the significant benefit – compared to battery electric vehicles – that it can be refuelled mid-race. Another option is cryogenic storage of liquid hydrogen. Kapus believes this may be possible for a

RIGHT Paul Kapus is project manager

BELOW The company recently invested heavily in expanding its test infrastructure for fuel cell and hydrogen technology

> *"AVL expects to achieve around 150 kW per litre, comfortably in the same performance window as domestic touring car competitions"*



racecar, but questions whether it would work for a road car.

At this early stage of development, much of the discussion focuses around the challenges that AVL RACETECH expects to encounter. The majority of this is detail development – it's breaking new ground, but the underlying concepts aren't radically different to a gasoline engine. That in itself could be a huge positive, with the energy density, the emotional engagement and the comparative affordability of combustion engines. Just imagine a field of thundering V8s or rasping four-cylinder turbos without the negative environmental connotations of fossil fuels.

Of course, hydrogen is not the only potential solution for combustion engines. Sustainable gasoline, such as e-fuel, is effectively vying for the same market. That has the key advantage that it's a drop-in substitute that can be used with a totally unmodified engine, but things get more complicated when you take a holistic view.

The first issue to consider is the energy required to produce the fuel. As a very rough estimate, producing e-fuel takes around five times as much energy as charging a battery, while hydrogen is approximately three times as much.

"There is a challenge here, because there is very little sustainable hydrogen at the moment, but that is something that people are working on," comments Kapus. "We are starting to see prototype plants that can produce green hydrogen. Once you have that, you could produce hydrogen somewhere that there's plentiful access to renewable energy, such as Chile or North Africa, and then ship it around the world. That's not something you can do with electricity."

The same argument applies to e-fuel, for which hydrogen is a key constituent. But to process hydrogen into e-fuel requires a series of costly and energy-intensive additional steps. And then there's the question of emissions. E-fuels and biofuels still emit carbon dioxide at the tailpipe. In theory, this can be cancelled out by the carbon-negative process involved in their production (for instance, if carbon capture from ambient is used or if plants are grown to produce the feedstock for biofuel) but that outsources the emissions to a different location and may be hard to trace and validate. Hydrogen combustion, on the other hand, produces no CO2.

"E-fuel works well if you can take a complete well-to-wheel view, but in most places the legislation only looks at the local emissions," comments Kapus. "Will you be allowed to run as a zero emissions vehicle if you are taking CO2 out of the air in Chile and releasing it in Europe? I don't know."

AVL also works on fuel cell development, and the technology has its own advantages, including zero NOx emissions. But they're also expensive to produce, and once you've combined the fuel cell with the motor and batteries, they're heavy.

Ultimately, though, all of these options could – and probably should – remain on the table. Hydrogen may have been somewhat overshadowed by battery electric storage, but recent events – including one country reportedly considering a temporary ban on electric vehicle charging to ease the energy crisis – have highlighted the danger of relying too heavily on one technology. RT

MONSTERS OF THE DUNES SEEK AN *AUTOMATIC* ADVANTAGE

IVECO
versteijnen trucks

We can expect a clean sweep of fully automatic transmissions when the front-running trucks tackle this month's Dakar Rally. **Mark Skewis** talks to Gerard de Rooy, owner of Team De Rooy, to find out what's behind this recent transition

THE Dakar Rally presents one of motorsport's biggest challenges to vehicle drivelines, regardless of the type of vehicle entered. Extremes of temperature and terrain are encountered daily as the event crosses Saudi Arabia, from the beaches of the Red Sea to the sands of the Arabian Gulf in Dammar. For the competitors, reliability is as important as performance.

Entrants in the truck class use a diverse range of manufacturers' commercial offerings as the starting point for their rally vehicles, but the front-running trucks have, over the past few years, gained consensus in sharing one common driveline component: a fully automatic gearbox.

On and off-road, fully automatic transmissions are commonly used in specialist heavy-duty applications, dominating applications such as fire-appliances, defence and municipal vehicles, with automated manual gearboxes (AMTs) – manual transmission (MT) with electronic-controlled clutch and gear actuators – remaining the default choice in mainstream road freight trucking. The reverse is true in the rally-truck arena: last year's Dakar saw Allison transmissions used by all the top 10 trucks, and score significant success in other events too.

Gerard de Rooy is team principal and owner of the four-truck Dutch-based team that bears his name. In recent years Team De Rooy has used IVECO trucks exclusively fitted with the Allison 4000 Series transmission to score consistent successes in the Dakar event.

"First and foremost, the fully automatic gives us easier driveability," explains de Rooy. "Previously, we used a 16-speed manual gearbox, but given the high power and torque of our ▶

LEFT The fully automatic transmission option reduces driver fatigue across an event featuring 15 days of cross-country racing interrupted by only one rest day

> *The 4000 Series transmission pairs well with any energy source: electric, natural gas, diesel or hydrogen”*

engines and the relatively light weight of our vehicles compared to a loaded commercial truck, we only actually used six of the gears!

“Even with hydraulic assistance, it took time and effort to change gear, and the breaks in torque needed to make the change hampered acceleration. In contrast, the fully automatic makes changes under full power without interruption.

“Initial acceleration is further enhanced because you can use the Allison as a launch control: you can rev the truck up at a standstill, pressurising the system and using the pressure in the system to multiply the torque. We haven’t actually measured the two transmissions against one-another, but I’d say acceleration is easily one-third faster with the fully automatic.”

Another advantage, he says, is reduced driver fatigue: “The fully automatic will select the correct ratio for the situation without intervention, allowing the driver to concentrate on speed and direction. For certain situations, the driver can over-ride the transmission and select a particular ratio, but this is unnecessary for 95 per cent of the time.”

Anything that can be done to reduce driver fatigue in an event that sees 15 days of cross-country racing with only one rest day is welcome, given that each day sees the trucks cover between 500 and 600 km on a mixture of liaison (untimed) and special stages.

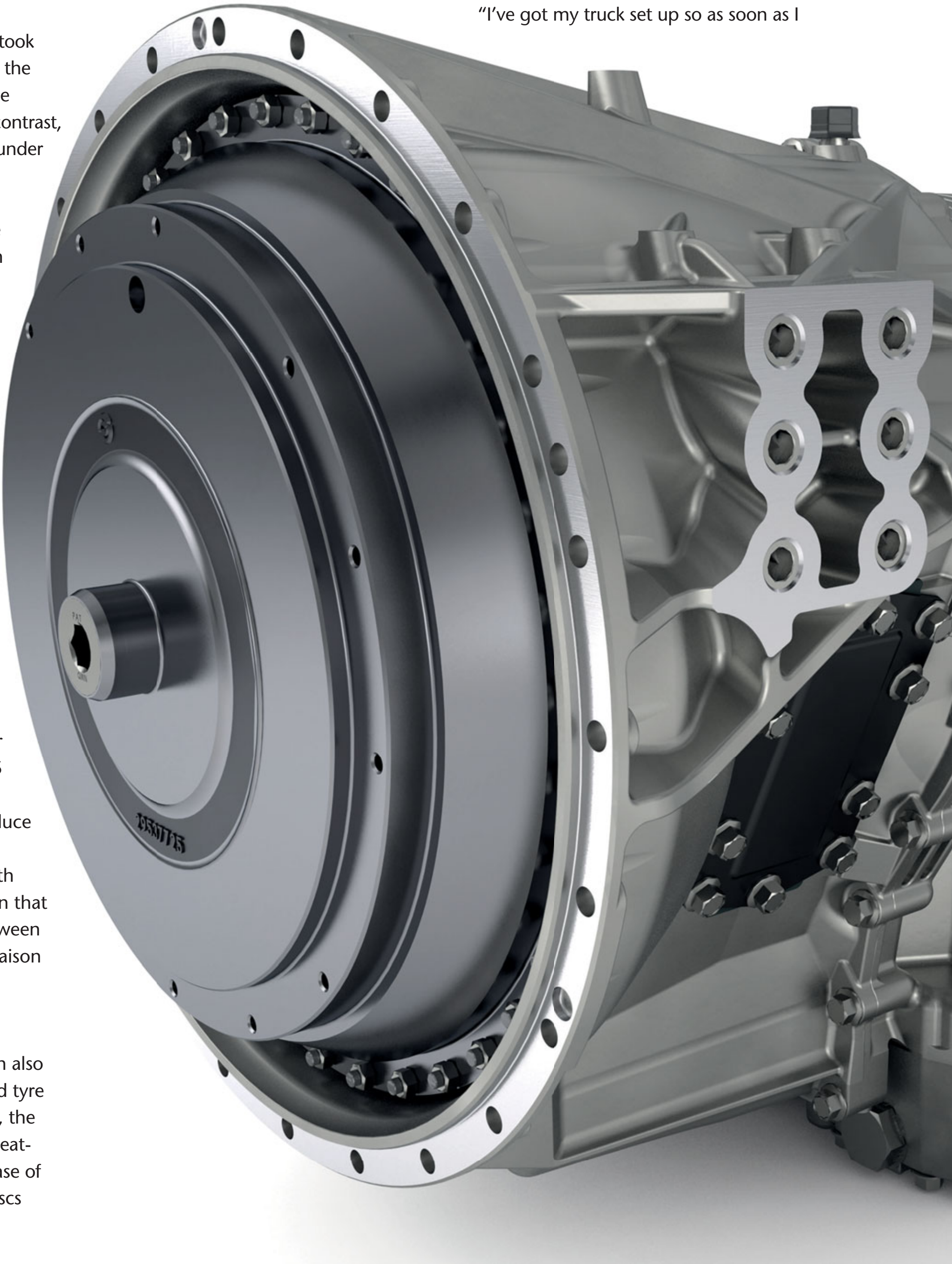
Improved tyre life

But the fully automatic transmission also has another great benefit: increased tyre life and reliability. As with all trucks, the wheels play a significant role as a heat-sink for the brakes, which, in the case of de Rooy’s IVECO Powerstars, are discs all round. The tyres, which on de Rooy’s trucks are Goodyear products intended for commercial heavy-duty off-road and quarrying markets, are pushed very hard by the rigours of rallying, where the trucks become airborne off the tops of dunes, and drive across sharp rock formations at high speed. The additional heat from the truck’s brakes could well be enough to cause a failure, which at the very least means a time- and energy-consuming stop to change a wheel, and can even put a truck out of the event if all the spares are used on a stage and a team-mate cannot get to the truck to assist.

The Allison transmission features an integral hydraulic retarder, which reduces heat build-up in the wheels and tyres considerably.

“We use the retarder a lot. For sure we see a big drop in the wheel temperature because of this, which extends the tyre life and reduces the risks of failure. We also don’t have brake fade, as the retarder does most of the braking,” de Rooy explains.

“I’ve got my truck set up so as soon as I



PETRONAS
Urania
BESTRONICS
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Allison Transmission
YEAR
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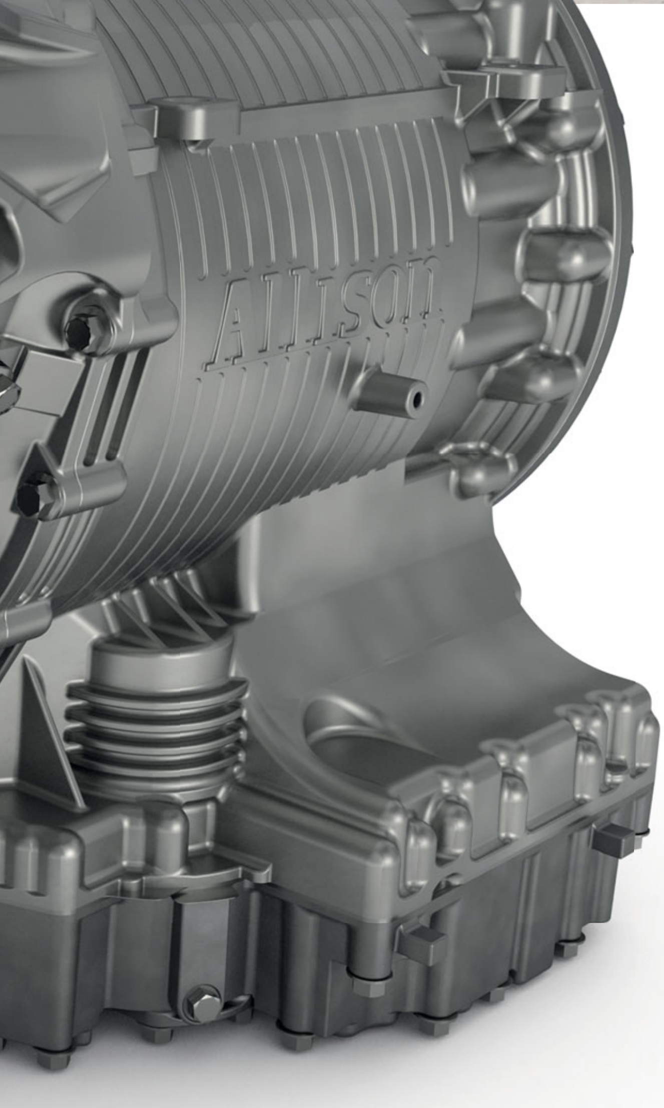
ABOVE Representatives from Allison Transmission visited Team De Rooy at its premises near Eindhoven, in the Netherlands, to sign the latest partnership. Left to right: Sjoerd Vos, Director Marketing, EMEA, Allison Transmission; Gerard de Rooy, owner of Team De Rooy; and Edgar Lips, Senior OEM Account Manager, Allison Transmission



LEFT The Allison 4000 Series transmission has consistently enjoyed success on the Dakar Rally, one of motorsport's last great adventures

lift off the accelerator, the retarder is actuated. Some of the other drivers prefer to have it operated by the initial travel of the brake pedal. The Allison transmission can be set to accommodate individual preferences."

In addition, the transmission retarder is backed by IVECO's Combined Engine Brake: this combines compression release at the top of the stroke with a butterfly valve in the exhaust manifold to increase back-pressure on the over-run.

Such is the effectiveness of this blended retardation that the trucks typically run the same set of discs throughout the rally, and only need three or four pad changes, which is remarkable given the harsh operating conditions.

De Rooy says that stresses on the truck change according to terrain: "In past events in South America we drove more on fast WRC-style stages, which wore the brakes more but were lighter on the suspension than the rougher terrain we encounter in Saudi."

Reduced shock loading

Fully automatic transmissions also extend the life of other components: they reduce shock-loadings on hubs (which incorporate reduction gears), the differentials, and the propshafts. Furthermore, there is no manual clutch to overheat: the punishment is absorbed by the transmission fluid in the torque convertors, and the transmission's clutch packs are cooled by the fluid itself.

Incredibly, de Rooy's experience is that the transmission itself requires minimal attention during the rallies.

"We check for electronic fault-codes, we check for fluid leaks and we check the fluid level, and ▶

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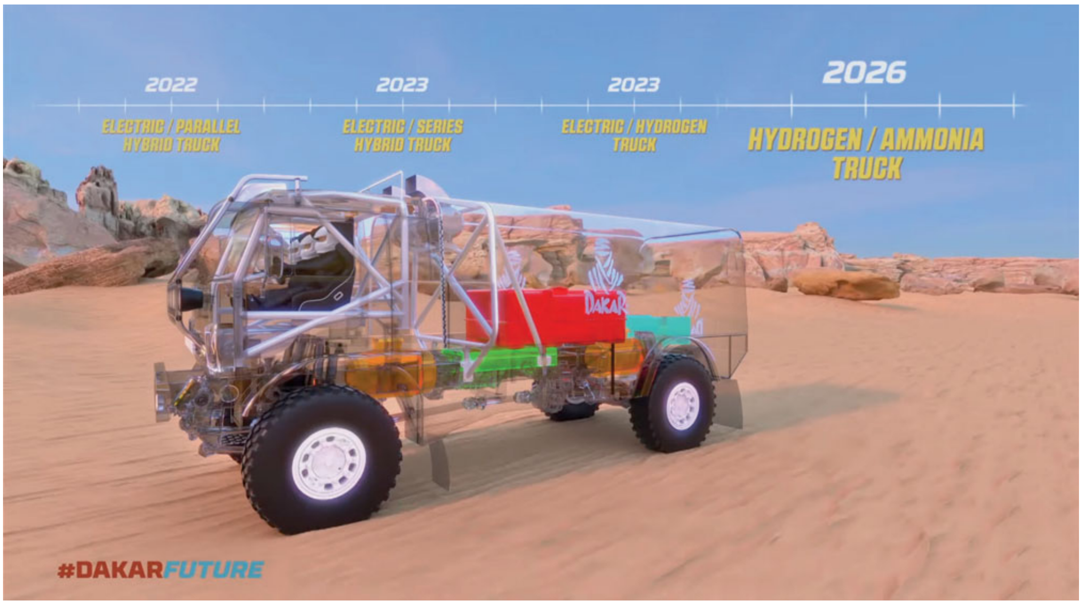
LEFT Allison is also helping Team De Rooy recreate a legendary vehicle from its past: the famous 1984 Two-Headed Monster Dakar truck that has a cab at each end and two separate drivelines


2022
ELECTRIC / PARALLEL HYBRID TRUCK
2023
ELECTRIC / SERIES HYBRID TRUCK
2023
ELECTRIC / HYDROGEN TRUCK
2026
HYDROGEN / AMMONIA TRUCK
DAKAR
#DAKARFUTURE

BELOW LEFT The multiple-time Dakar-winning team recently entered into a three-year partnership agreement with Allison to develop electrically-powered trucks for the event's energy transition

that's it," he says. "At the end of each event, the transmission is sent away for a precautionary strip and rebuild by our trained technicians."

The rebuilds normally reveal surprisingly little wear, according to Crispijn Wind, Associate Director Customer Integration Engineering at Allison Transmission. "Sometimes, some of the clutches show signs of heat degradation, but not enough to impact on performance," he reports. "This can happen when the driver lets the truck 'hunt' between two gears. A small change in technique is usually sufficient to prevent this."

Road vs Rally-Raid

Allison transmissions used in rally-raiding are mechanically identical to those sold for commercial use, he says. "Calibrations are changed to suit customer requirements. The various teams obviously use different engines, and transmissions' shift characteristics are adjusted to suit the power outputs and engine speeds of each, then individual drivers have their own preferences and we can fine-tune to accommodate these. The actual software is carried over from the commercial transmissions, just with customer-specific settings applied to a general setting for competition.

"One major difference between the commercial and the competition set-up is clutch pressure. Just as tuned vehicles with conventional drivelines will usually have heavy-duty clutch springs to accommodate the extra torque, so the clutches on our rally transmissions will run at a higher operating pressure than they would commercially, as outputs of the rally engines can double that of the parent commercial unit.

"The 4000 Series is commercially available with a choice of wide or close-ratio gearsets. Our rally customers use the close-ratio option, as the trucks are limited to a top speed of 140 km/h, so there is nothing to be gained from a wide ratio spread. The trucks themselves also have mechanical transfer 'boxes giving a high and low range, and the relatively light weight and extremely high torque of the rally trucks mean that second gear is usually selected for starts: first is for emergencies, and recovering other vehicles that have become stuck. It is selected manually, when required."

Two-Headed Monster

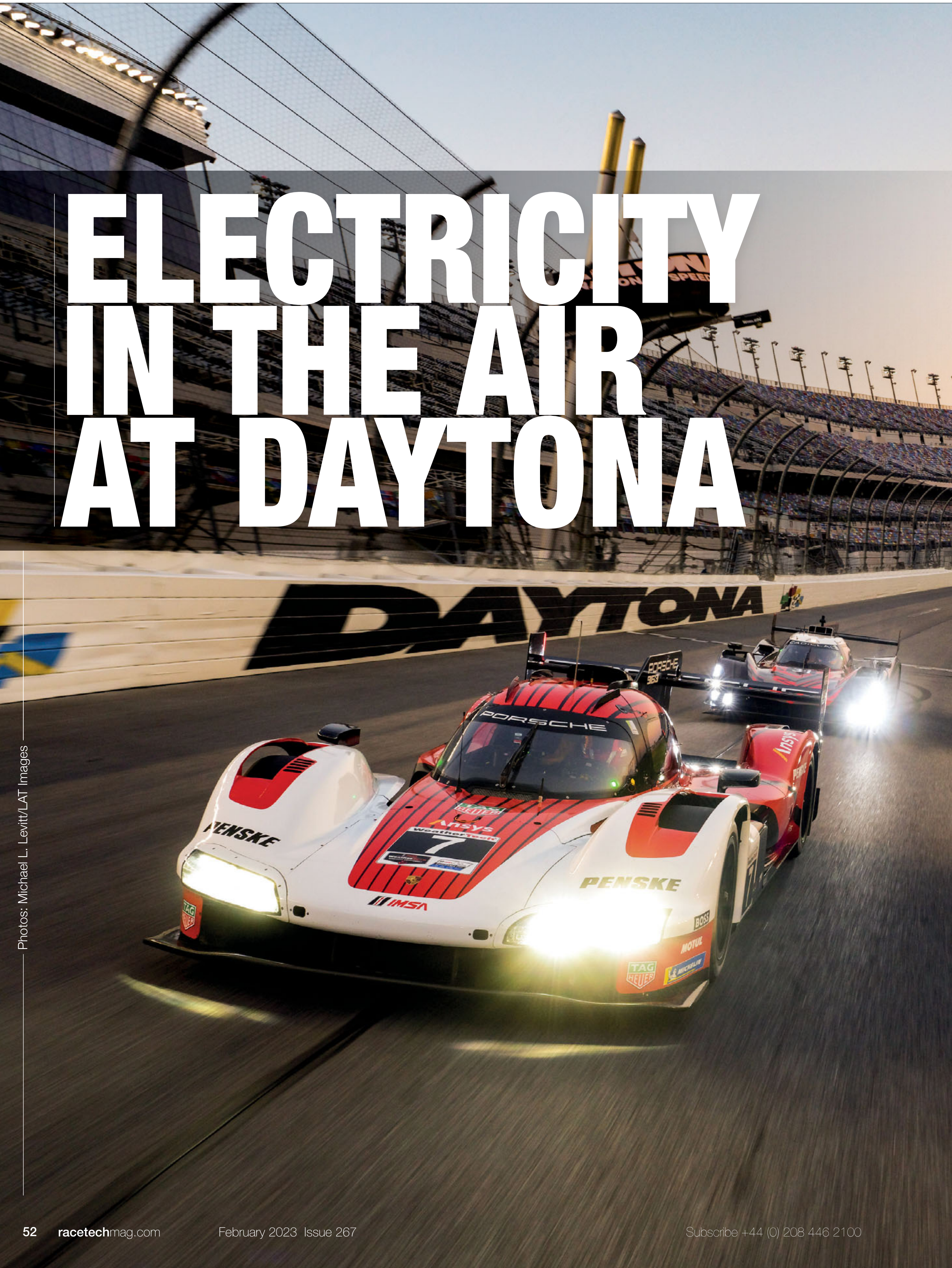
Allison is also helping Team De Rooy recreate a legendary vehicle from its past: the famous 1984 Two-Headed Monster Dakar truck that has a cab at each end and two separate drivelines, each powering an axle. In its initial iteration, this had two manual gearboxes synchronised with mechanical links, but these are now being replaced by a pair of Allison's lighter-duty 3000 Series transmissions synchronised electronically. The 3000 Series, incidentally, is used on the Hino Team Sugawara Dakar rally trucks competing in the under 10-litre engine class.

Looking to the future, Team De Rooy is developing an electric rally truck. Much of the layout is still to be decided, with Gerard de Rooy explaining that there are questions as to whether it should be a pure electric with changeable batteries, or with fixed batteries and a range-extending combustion engine.

He is, however, sure that it will have an Allison Series 4000 transmission, which pairs well with any energy source: electric, natural gas, diesel or hydrogen. This may be a surprise given that the commercial battery-electric trucks coming onto the market have simple two-speed gearboxes. But the torque-amplifying qualities and multiple ratios of the fully automatic will allow a smaller traction motor to be used, extending the truck's range.

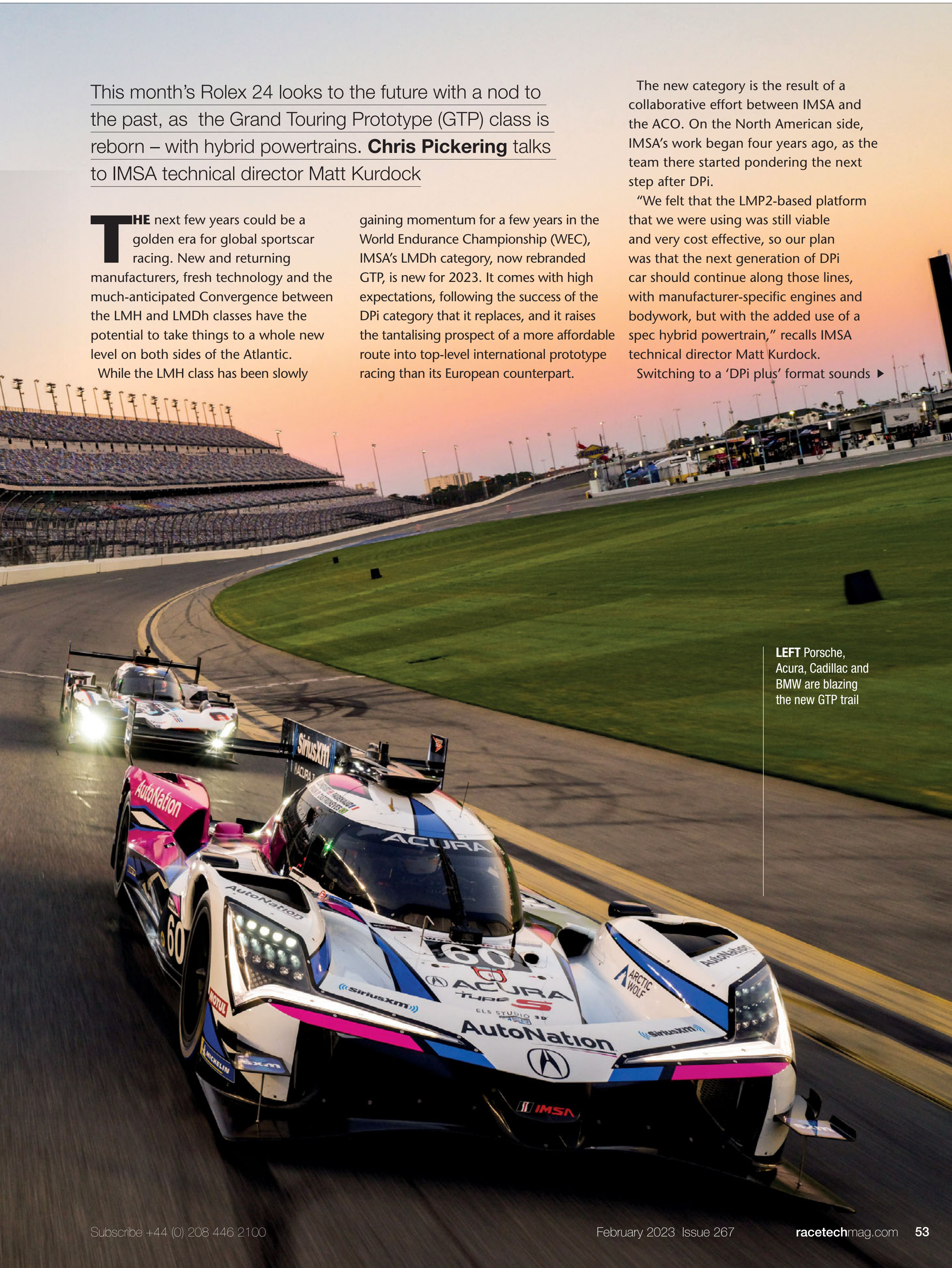
While the electric truck will feature regenerative braking, with the traction motor being used as a retarder and returning energy to the batteries, this will only work if the batteries have been discharged sufficiently to make room for the returning energy without an excessive heat build-up. So there will still be a role for the transmission's integral retarder in providing braking without compromising the tyres at certain phases of the event. RT

BELOW The Allison transmission features an integral hydraulic retarder, which reduces heat build-up in the wheels and tyres



ELECTRICITY IN THE AIR AT DAYTONA

Photos: Michael L. Levitt/LAT Images



This month's Rolex 24 looks to the future with a nod to the past, as the Grand Touring Prototype (GTP) class is reborn – with hybrid powertrains. **Chris Pickering** talks to IMSA technical director Matt Kurdock

THE next few years could be a golden era for global sportscar racing. New and returning manufacturers, fresh technology and the much-anticipated Convergence between the LMH and LMDh classes have the potential to take things to a whole new level on both sides of the Atlantic.

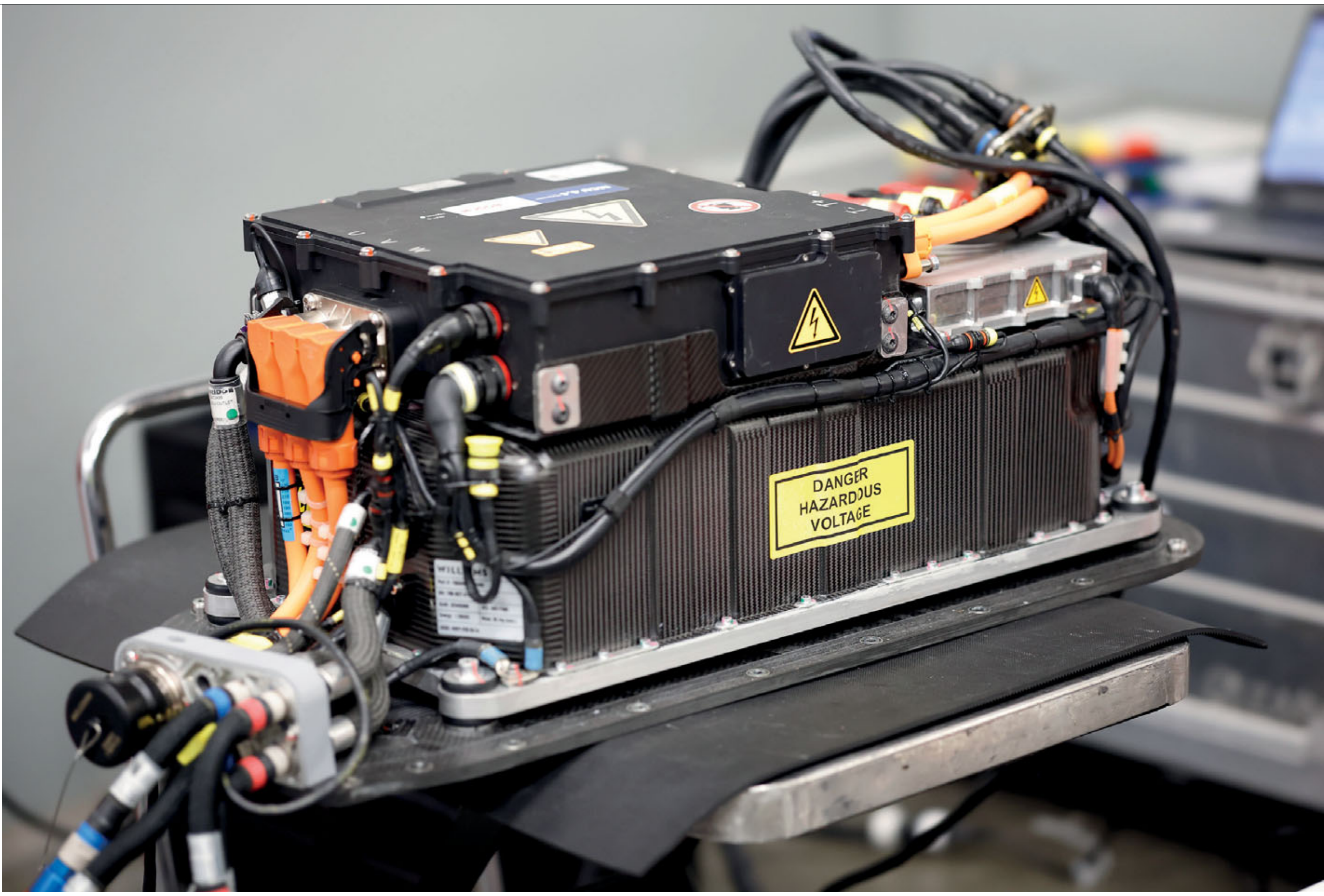
While the LMH class has been slowly gaining momentum for a few years in the World Endurance Championship (WEC), IMSA's LMDh category, now rebranded GTP, is new for 2023. It comes with high expectations, following the success of the DPi category that it replaces, and it raises the tantalising prospect of a more affordable route into top-level international prototype racing than its European counterpart.

The new category is the result of a collaborative effort between IMSA and the ACO. On the North American side, IMSA's work began four years ago, as the team there started pondering the next step after DPi.

"We felt that the LMP2-based platform that we were using was still viable and very cost effective, so our plan was that the next generation of DPi car should continue along those lines, with manufacturer-specific engines and bodywork, but with the added use of a spec hybrid powertrain," recalls IMSA technical director Matt Kurdock.

Switching to a 'DPi plus' format sounds ▶

LEFT Porsche, Acura, Cadillac and BMW are blazing the new GTP trail



like a simple solution in theory. However, the LMP2 chassis used in the series were not designed with hybrid drivetrains in mind, so extensive changes would be required. Consequently, the discussions with the ACO shifted towards the concept of a new platform – one that would essentially be built for LMDh but with future LMP2 use also in mind.

From that point onwards, LMDh and LMH evolved alongside each other. It's here that the concept of 'Convergence' entered the equation, with the ultimate goal of allowing cars from these two categories to compete directly against one another.

Neat solution

For Kurdock and his colleagues at IMSA, the problem of packaging the spec hybrid components remained, but they've since found a neat solution. Each of the four LMDh-approved chassis has its own design, but they share a common volume. Here, the high voltage components, including the battery, motor controller and DC-DC converter, are installed from underneath, sitting beneath a 'false floor' on the passenger side, which keeps them isolated from the cockpit. This common location on all four chassis also allows most of the wiring between the motor controller, mounted just above the battery, and the MGU on the gearbox to be shared.

IMSA is said to have spoken to no less than 15 manufacturers at various times to gauge the potential range of different engine architectures that could theoretically be encountered before the end of the current homologation era in 2027. Discussions began with hybrid parts suppliers Xtrac, Bosch and Williams Advanced Engineering to ensure that all these options could be accommodated. In the end, the length between the monocoque and the gearbox was set at 640 mm, allowing a V12 to be accommodated at a squeeze, while the crankshaft centreline was set at a minimum of 106 mm above the reference plane.

"You don't know what could be coming, and you certainly want to create a platform that allows that aspect of the car to be unique," comments Kurdock. "We wanted them to be able to have their own brand identity. If you put different bodywork on the cars but they're all the same underneath, what have you achieved? For sure, with the four LMDh cars that have been testing, there are four very distinct sounds coming out of those cars. And that's exciting for us."

> *"A huge software and integration challenge will be one of the main technological battlegrounds"*

ABOVE The LMDh battery from Williams Advanced Engineering is all about packing a punch in a small package, with a very high charge and discharge rate

ABOVE RIGHT It was a challenge to install the hybrid MGU (silver) between the back of the engine and the front of the gearbox

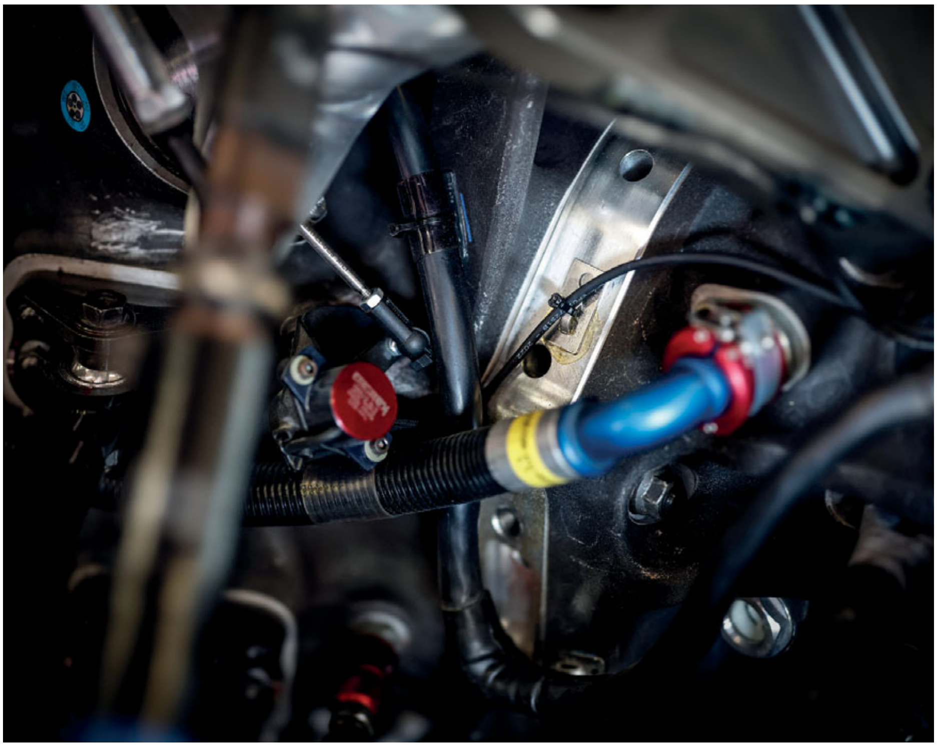
RIGHT Xtrac's P1359 gearbox developed for LMDh is a 7-speed transverse arrangement with an integrated motor-generator unit (MGU) driving into the gearbox through an optimised gear train

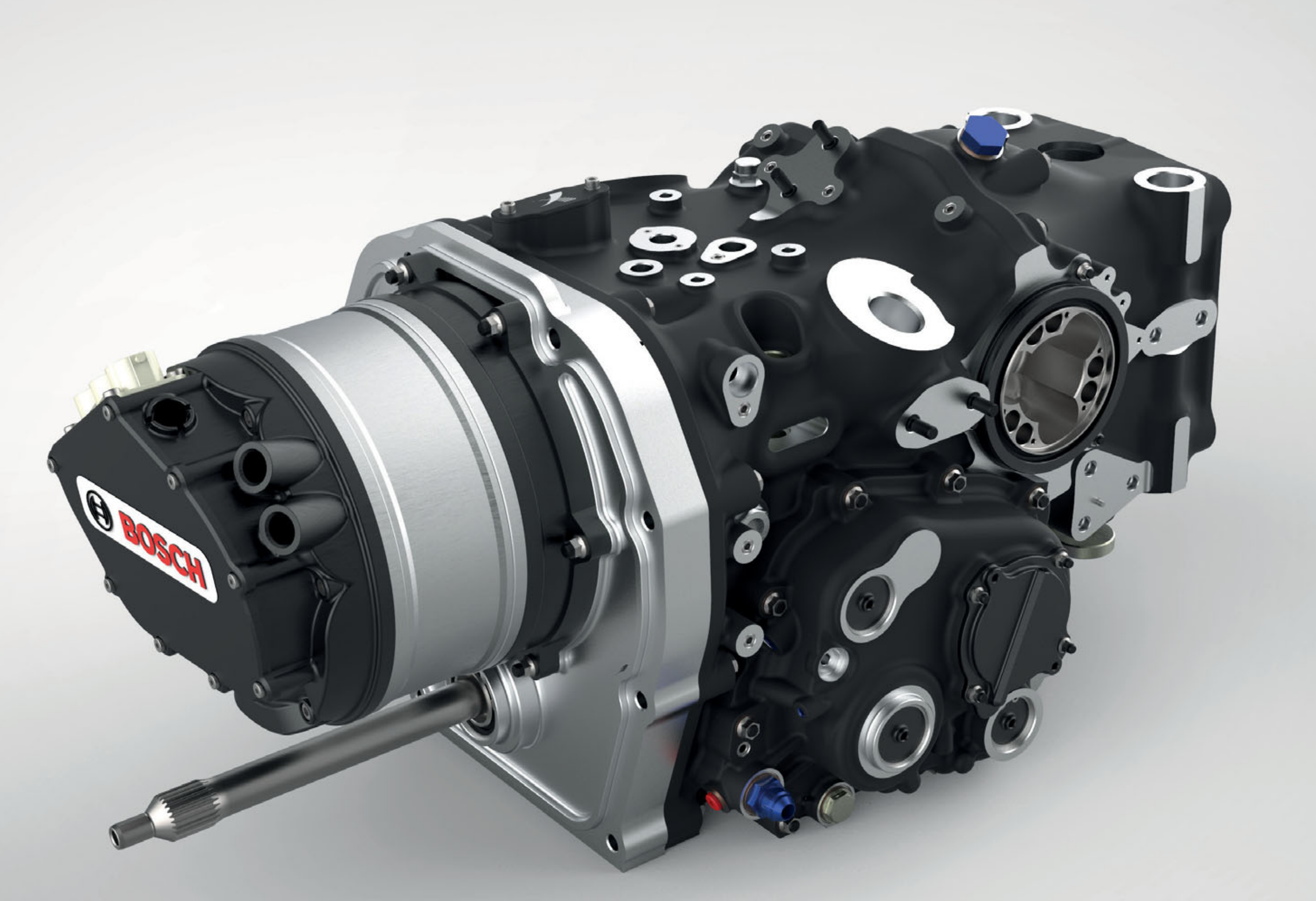
The MGU is installed on the front face of the gearbox, so a big part of the challenge was to find sufficient room between the back of the engine and the front of the gearbox, while retaining a keep-out zone around the bellhousing that still allowed the manufacturer to use their choice of clutch and the throw-out mechanism.

Another key aim with the introduction of the new platform was to improve safety. The greenhouse is now a little bigger than on the old cars, providing greater visibility, plus there's better anti-intrusion materials used on the side of the cockpit.

Convergence

Aside from the move to hybrid powertrains, the biggest talking point with LMDh is perhaps the concept of Convergence itself. This process began by attempting to align the three key attributes of both categories – their weight limits, power levels and aerodynamic performance windows. After that, the FIA, IMSA and the ACO moved ▶





on to more nuanced factors, such as tyre performance, all-wheel drive, the hybrid system's impact on traction control and differential locking characteristics.

"After we had the basics figured out, we went into the next layer of detail," comments Kurdock. "We had to make concessions in both regulation sets to try to better equalise not just the lap times but how the lap is put together and how that would vary across a full tyre stint. That's where there were some differences between the two platforms that have hopefully been converged [as] we needed to get away from the reliance on balance of performance to fix those inherent discrepancies."

Equal footing

The expectation is that LMH and LMDh cars will be able to compete against each other on an equal footing as soon as they take to the track later this year, but only time will tell.

"I think it's important for the health of both LMH and LMDh that they're equalised at all the various circuits that IMSA and the WEC run at. And, you know, it's certainly taken quite a few years to get to that point, with all the LMH and LMDh manufacturers working alongside the sanctioning bodies towards that," notes Kurdock.

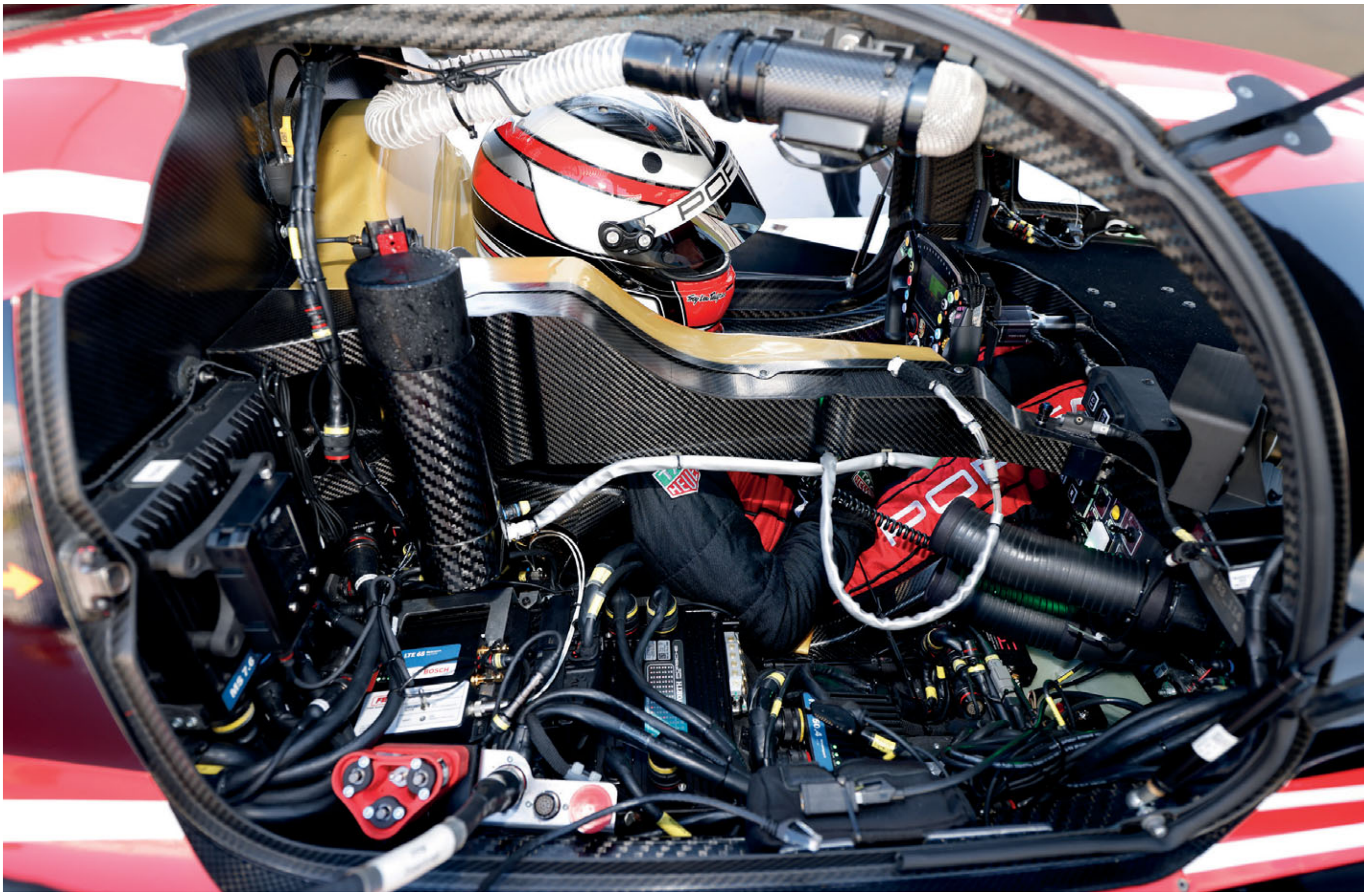
While both sides have their fingers crossed, there may still be an element of fine-tuning when the two categories first come together in a few weeks' time. Fortunately, Kurdock and his colleagues do have plenty of tools at their disposal if that happens.

"The use of driveshaft torque sensors as the primary method of controlling the ▶

ACURA Type S
HYBRID ELECTRIFIED
IMSA

ABOVE The hybrid drivetrain makes GTP the most sustainable form of motorsport in North America

BELOW Improved safety is a key aspect of the new GTP platform, with cars featuring a larger greenhouse than their DPi predecessors, plus better anti-intrusion materials on the side of the cockpit



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power output is a big advantage," he comments. "We're not just speaking the engine output; it's the total system output going to the wheels, so that's a pretty significant advancement in our ability to balance the straight-line performance of the cars."

The other big factor is the aerodynamic performance, he points out: "What's different to DPi is that the aerodynamic windows for LMH and LMDh are now quite small, and they always have to be within that window. Previously, we could see that some cars on some circuits would be better suited than others – perhaps due to the range of aerodynamic configurations and the size of the homologation window for those cars."

Aero homologation

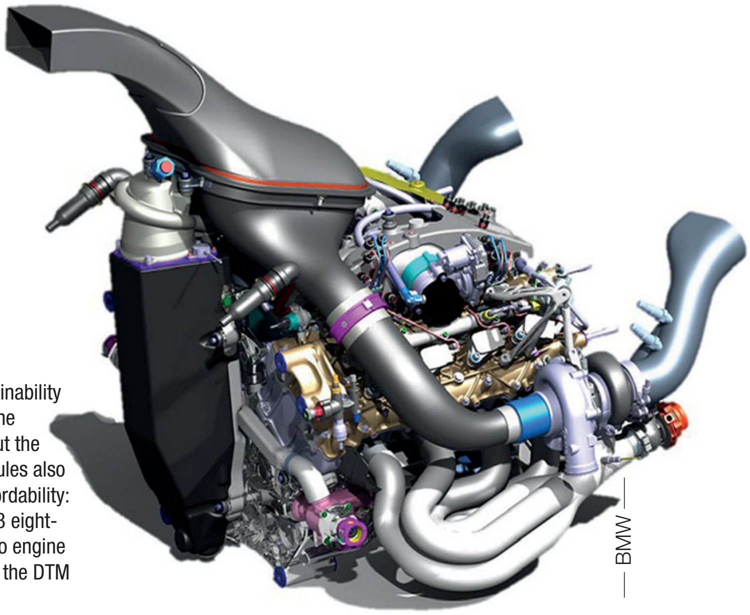
The aero homologation for all LMDh cars is carried out by IMSA and the ACO at the Windshear facility in North Carolina, while LMH cars are handled by the FIA and the ACO at the Sauber wind tunnel in Switzerland. As part of the Convergence policy, both groups follow exactly the same process in the wind tunnel.

"We have a very lengthy process of how the car must be prepared, before it goes to Windshear, and a prescribed test plan that includes a variety of yaw angles and ride height sweeps," comments Kurdock. "Once we've found the [range of] configurations for the car that remain within the prescribed window, those configurations are essentially locked down in the homologation."

One of the key changes from the DPi regulations is that the cars are now only permitted to run one adjustable aerodynamic device on the car, which is typically a rear wing with an adjustable main plane and flap. On top of that, each design is tested and given a range of homologated brake blanking options that keep it within the overall lift vs drag window.

Although the processes and the aero windows are both fully aligned for LMH and LMDh, each car must undergo an aerodynamic characterisation process before it can migrate to the other championship. As such, an LMDh car would need to visit Sauber to be tested before taking part in the WEC, while an LMH car would need to characterised at Windshear before it could cross-over to IMSA. ▶

ABOVE The aerodynamic windows for LMDh and its LMH equivalent are now quite small compared to the DPi era



— BMW —

RIGHT Sustainability might grab the headlines, but the new LMDh rules also focus on affordability: BMW's P66/3 eight-cylinder turbo engine originated in the DTM

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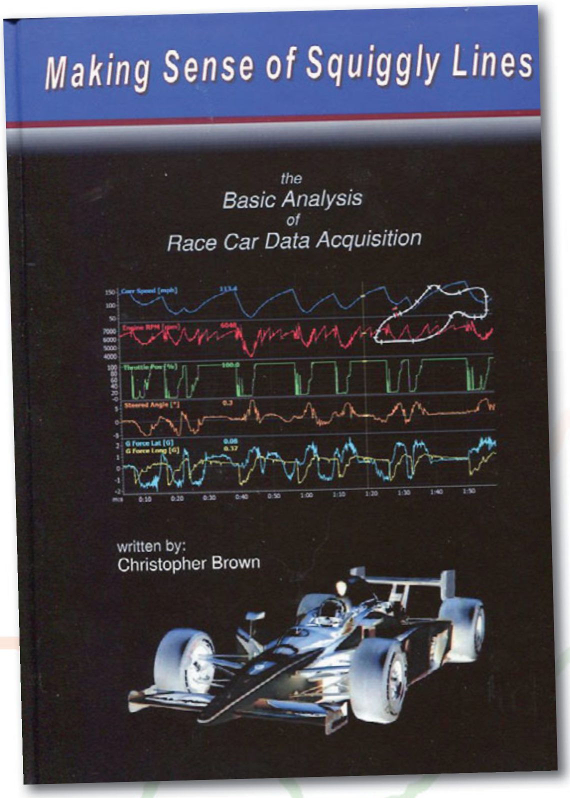

Table of Contents

CHAPTER 1 INTRODUCTION
1.1 – Data Acquisition System
1.2 – Channels
1.3 – Logging
1.4 – Data Display Types Chapter
CHAPTER 2 SPEED
2.1 – Speed from tire revolutions
2.2 – Speed from GPS
2.3 – Overlay
2.4 – Variance
2.5 – Data Alignment
2.6 – Braking
2.7 – Wheel Slip
2.8 – Cornering Speeds
2.9 – Straight Line Speed Chapter
CHAPTER 3 RPM
3.1 – Over Revs
3.2 – Down Shifts
3.3 – X-Y Plot of RPM vs. Speed
3.4 – RPM Histogram
CHAPTER 4 GEAR
4.1 – Finding the Optimal Shift Points
Chapter 5 Throttle
5.1 – Throttle Blips
5.2 – Average Throttle Position
5.3 – Throttle Lifts
5.4 – Throttle Application Smoothness
5.5 – Throttle Application – Ideal Line
CHAPTER 6 G-FORCE
6.1 – G-Force Longitudinal – Acceleration
6.2 – G-Force Longitudinal – Braking
6.3 – G-Force Lateral
6.4 – G-G Traction Circle
CHAPTER 7 STEERING
7.1 – Line Analysis
7.2 – Car Handling Oversteer/Understeer
CHAPTER 8 TRACK MAPPING
CHAPTER 9 SECTION TIMING
CHAPTER 10 VIDEO
CHAPTER 11 PUTTING IT ALL TOGETHER
11.1 – Summary of Channels
11.2 – Strategy for Improvement

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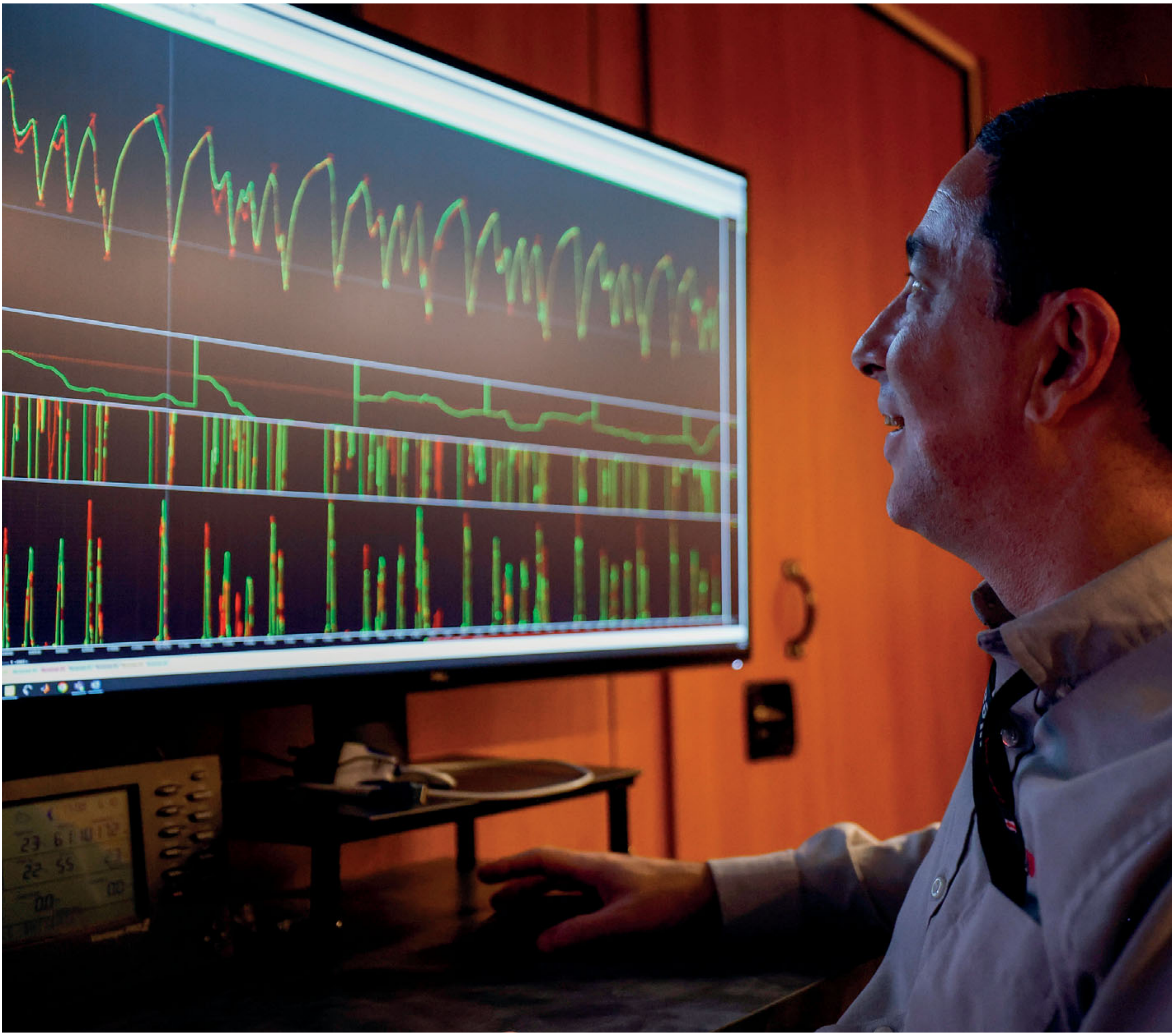
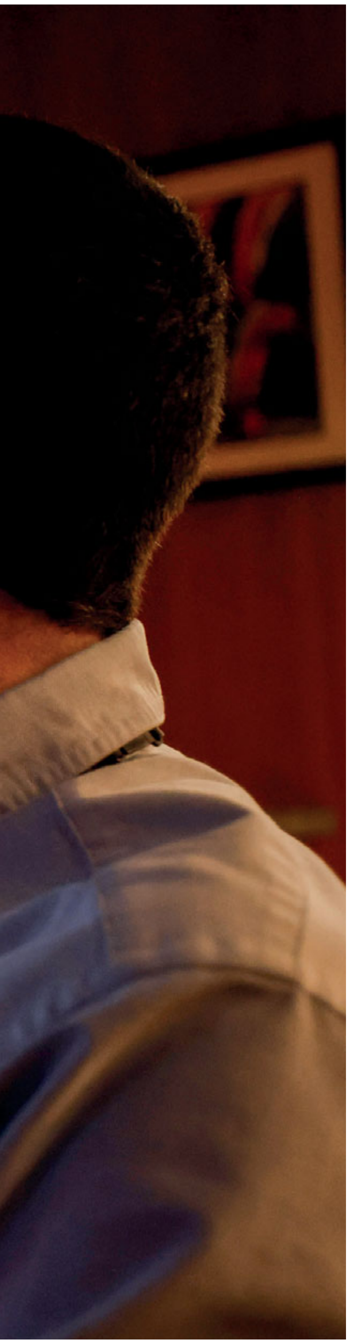
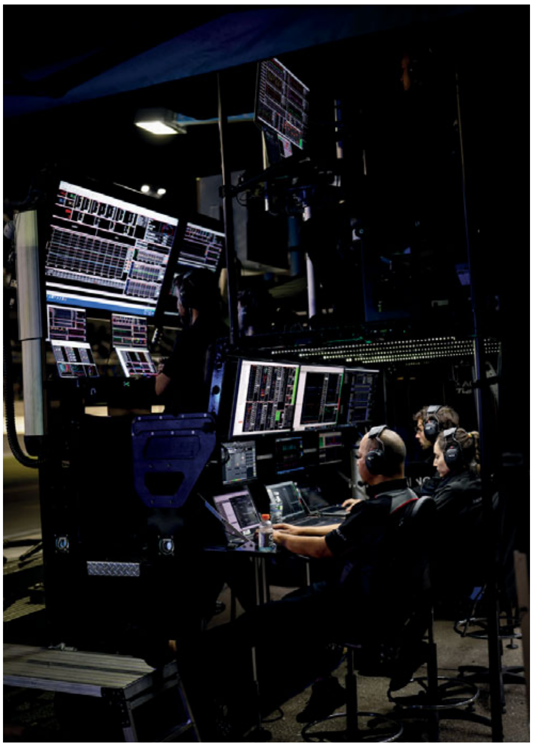
BELOW & LEFT IMSA technical director Matt Kurdock monitors the data. He says the flow of information from the new cars' sensors has played a big role in making sportscar racing's convergence possible





RIGHT Optimising the software will be a pivotal battleground for the new category



"We've had the opportunity to take the same car into both tunnels and compare the data," says Kurdock. "Obviously that creates a layer of complexity that we'd like to remove if we could do it again and converge on one tunnel, but as you can imagine there are logistical challenges associated with that, which is why we've come up with common homologation methods and procedures between the two."

The wind tunnel data from the homologation process also feeds directly into the simulation work that's used to formulate each car's initial balance of performance (BoP). In theory, this could result in an aerodynamically identical car running two different BoP values in the separate championships that would reflect any variation between the two wind tunnels. This, however, is academic as all cars at a given event will be running to the characterisation results carried out at the same wind tunnel – so even if the two were to differ you'd never get a car running in the WEC to its IMSA BoP or vice versa.

Software challenge

While the hybrid system may rely on spec hardware, there's still a huge software and integration challenge that has been left to the individual manufacturers. Kurdock believes this will be one of the main technological battlegrounds in the new series.

"Bringing a hybrid system into the equation was a key part of the LMDh template, but it does make the cars become quite a bit more complex," he says. "You've got an MGU that's basically spinning as a function of the input shaft speed. That's directly coupled to the engine, so there are certainly some challenges around synchronising things like gear shifting and traction control. I think a lot of development has been on getting this common hybrid system to work with each manufacturer's specific engine the way they want it to on the racetrack."

As always, the organisers are chasing a tricky balance. They want to provide the teams with a reasonable range of adjustment, without leaving them so much freedom that costs begin to spiral.

> *"The use of driveshaft torque sensors as the primary method of controlling the power output is a big advantage"*

"If the manufacturers were allowed a bespoke system, I'm sure that they would all do things slightly different, but with a common system, everyone's had to make compromises to get a package that works in all these different cars that we're going to see," says Kurdock.

"Unfortunately, this introduces a degree of inherent complexity – we're talking brake-by-wire, a high-voltage hybrid system and very complex engines that are all trying to work together at the same time with common gearbox. So, yeah, it's certainly been a challenge."

Of course, the more fundamental challenges relating to endurance racing haven't gone away either. Reliability will be paramount, especially at the longer events like Daytona and Le Mans.

The future beckons

Although it has evolved somewhat along the way, LMDh essentially remains true to the DPi philosophy that originally inspired it. With the automotive industry evolving at unprecedented pace, the next evolution may have to be more radical, and it's already something that Kurdock is contemplating.

"The LMDh platform took us around four years to develop, so for sure, we're starting to look at what comes next," he says. "My personal opinion is that the electrification aspect that we've introduced is probably here to stay. Whether that's an increased contribution of the hybrid system in the future generation or whether that is some alternative powertrain, we'll see. But it's clear that the automotive environment is changing. And the motorsport environment is a marketing platform for our automotive partners, so it needs to stay relevant to that."

Whatever the next generation might hold, the immediate future looks like a mouth-watering prospect for endurance racing fans, especially with yet more high-profile manufacturers slated to arrive in 2024. With the first race of the LMDh era now just weeks away, we won't have to wait long to see how it shapes up. RT

TURNING IDEAS INTO PARTS ON THE CAR – FASTER THAN EVER BEFORE

Team Penske became the first team ever to pull off the historic NASCAR-IndyCar title double last season. **Chris Pickering** discovers one of the secrets behind its success

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THERE are some pieces of modern technology that feel like they belong in the realms of science fiction. No matter how many times you watch a 3D printer churning CAD drawings into physical parts, for instance, it still feels like something that would take place in a galaxy far, far away.

The reality, of course, is that additive manufacturing is now a well-established tool in the day-to-day running of a modern racing organisation. At Team Penske's HQ in Mooresville, North Carolina, additive manufacturing has been in use since 2002. During that time, its scope has expanded to cover numerous different applications, including wind tunnel parts, functional parts on the racecar, jigs and fixtures for manufacturing, prototypes for engineering components and composite tooling.

Penske uses a mixture of stereolithography (SLA) and fused deposition modelling (FDM). SLA is one of the original additive manufacturing processes, with roots stretching back to the 1980s, and it uses a tank of liquid resin that's solidified with a laser. FDM, meanwhile, works by extruding a thermoplastic filament through a heated nozzle.

Recent advances in additive manufacturing technology and materials development have seen these techniques finding more and more applications within the organisation, explains Team Penske's production manager, Matt Gimbel.

He points to the arrival of carbon fibre-reinforced nylon materials such as Nylon 12CF from the team's additive manufacturing partner, Stratasys. This combines Nylon 12 and chopped carbon fibre, which is said to provide enough strength and rigidity to replace metal in some applications.

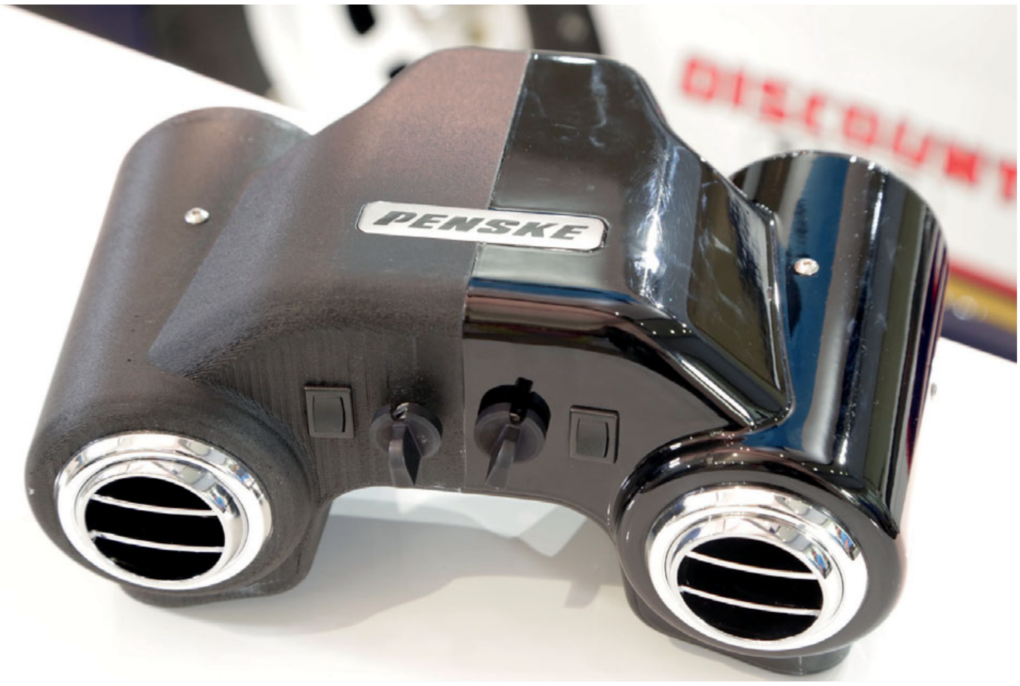
"Nylon 12CF was a big step for us," comments Gimbel. "We're able to put stronger parts on the cars. It's often used for things like brake ducts, where we need a material that's light but strong enough to cope with use on the track."

In these applications, the FDM parts are generally replacing those that would have been hand laid in carbon fibre, he points out: "You can imagine the time and energy that used to be involved in ▶

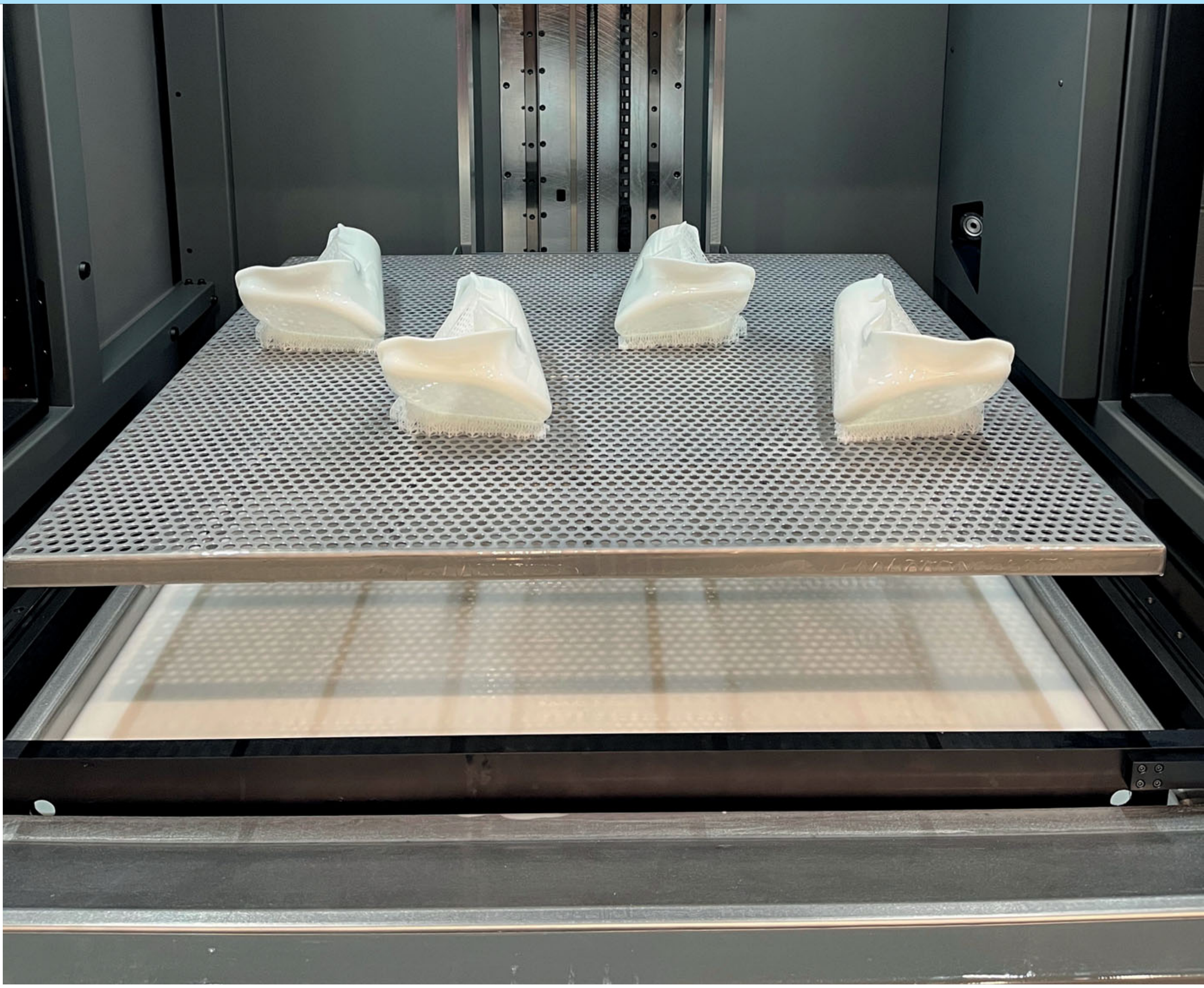
LEFT Ford's approach to tackling the Next Gen NASCAR led to an increased workload for Team Penske – and a third Cup Series championship

Getty Images/NASCAR

LEFT These daytime running light LED lenses were used on Penske's Acura DPi sportscars from 2018–2020. They were printed in Stratasys VeroClear on a J750 polyjet printer as part of a headlight repackaging project. Originally these lenses were made of cast polycarbonate. The team was able to eliminate mold redesigns and reduce its lead time from several weeks to eight days by printing them



RIGHT A cooling fan that the IndyCar teams use during practice sessions to cool the driver. The housing parts are printed in Nylon 12 CF on Team Penske's Fortus 900mc. Normally the units are fully painted, but for illustrative purposes half of the housing is left bare here



making a pattern and a mould and then laying up composite parts versus being able to print the same parts straight off the machine. For us, it can be the difference between getting those parts onto the racecar for that weekend or not."

New opportunities

While SLA continues to be used extensively, Penske's investment in FDM equipment has opened up new opportunities, Gimbel explains. This includes the ability to print sacrificial tooling for composite parts that's capable of withstanding autoclave conditions before being dissolved and washed out using a detergent solution. Other benefits are said to be the increased printing speeds of the latest FDM machines.

"We invested in FDM a few years ago, as we felt like we'd got as much as we could out of SLS and SLA," he comments. "We knew that there were some advantages with FDM that we weren't getting with the equipment we had at the time. One of the first projects we worked on with Stratasys was some wash-out tooling for composites, and that was probably the tipping point that really highlighted the fact that there were things we weren't able to do with our old equipment."

Early applications of this included composite overflow tanks for the NASCAR programme and air ducts to direct air flow under the engine cover in IndyCar. The benefits, we're told, were principally the simplicity of the process and its speed.

SLA still has its advantages, Gimbel points out. For all its benefits, the FDM process deposits material in distinct layers, with the resolution of the geometry limited by the size of the nozzle. As such, the precision laser process in SLA still tends to be better for detailed part geometries. Plus, SLA machines tend to provide a larger build platform. ▶

> *"The use of additive manufacturing has been an integral part of our mindset"*

ABOVE Brake caliper ducts on the Stratasys Neo800 3D printer

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Staying cool under pressure

3D printing has also improved safety – on and off the racetrack. By **Mark Skewis**

WHEN cooling emerged as one of the Next Gen car's teething issues, NASCAR used Stratasys Direct Manufacturing to print a windshield air cockpit ventilation unit.

The windshield air ducts were printed at Stratasys Direct Manufacturing in Belton, Texas on the SAF-powered Stratasys H350 3D printer. The parts were printed using Stratasys High Yield PA11, which is derived from sustainable castor oil. The parts were cleaned, finished, dyed and shot-blasted using DyeMansion post-processing equipment.

Additionally, the team at NASCAR designed and 3D printed an underside NACA duct for engine cooling at its research and development facility in Concord, NC with the Stratasys Fortus 450mc 3D printer.

"It is exciting to see the evolution of how NASCAR has used additive manufacturing across their vehicles. We've helped them move from 3D printed prototypes to end-use production parts on their high-performance race cars," says Pat Carey, Senior Vice President, Strategic Growth for Stratasys.

"The Next Gen car could not have been completed without the collaboration with NASCAR Competition Partners like Stratasys and Stratasys Direct Manufacturing," says John Probst, Senior Vice President, racing innovation, NASCAR. "During testing, we realised we needed an additive manufacturing solution that could withstand high temperatures and needed the parts delivered quickly.

"We approached Stratasys Direct, and they delivered not only as a supplier but as a consultant on this project. They provided us with strategic direction on design, materials, and the right additive manufacturing technologies to use."

The gestation period of the Next Gen NASCAR Cup car was delayed by the COVID pandemic. Even though the racing stopped, NASCAR's 3D printing machines did not: they played a key role in the fight to produce Personal Protective Equipment (PPE) for health workers. RT

LEFT Brandon Thomas, NASCAR Next Gen car designer, holding the 3D printed windshield air cockpit ventilation unit

> *"An engineer can send CAD drawings and we can have those parts printed and sat in their hands within a few hours"*

Additive culture

Over the years, additive manufacturing has become engrained at Penske, Gimbel explains: "I've been here 16 years and throughout that time the use of additive manufacturing has been an integral part of our mindset. Once we added FDM it gave the design engineers an additional element to their toolbox. An engineer can send us a few CAD drawings, and we can have those parts printed and sat in their hands within a few hours."

Much like working with traditional composite materials, it's important that the design engineers have a feel for the materials and the manufacturing processes. Penske has implemented its own set of drawing standards, which act as guidelines to ensure that the manufacturing engineers have all the information they require when a part comes through. The designers also need to be mindful of the part geometry and build orientation, as some of these materials are quite directional in their properties – just like traditional carbon fibre.

Similarly, it's the additive manufacturing department that adds any support structures required to facilitate the production of the design, but sometimes this has to be a collaborative effort with the design engineers.

Aero testing

Recent projects have included wind tunnel parts produced using SLA to support Ford and Penske's NASCAR activities.

"The introduction of the Next Gen NASCAR car certainly brought a lot of change," comments Gimbel. "With the way the rules changed, the teams really weren't allowed to develop their own cars anymore. That was pushed to the OEMs. So, instead, Ford made a concerted effort to really take the resources of the Ford teams and combine them together and start working towards ▶

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ABOVE Production manager Matt Gimbel discusses the installation of a 3D printed wingmirror housing

the goal of a unified aero programme. That certainly brought a lot of work for us, because we were now printing parts for different programmes that Ford was developing, along with aero mapping and understanding the car."

This can include almost anything on the top side of the car, along with occasional parts for the underfloor. The geometry is broken up into a mosaic of 16x16-inch tiles that can be assembled to create full panels.

"One of the big benefits to us from the SLA side is just being able to print new parts, get them tested in the wind tunnel, and then figure out what the change does, how it affects the car, and get that information to the race teams as quick as possible," comments Gimbel. "Back when the aero configurations were changing in IndyCar, we did more work on the SLA side. These days it just tends to be supporting aero mapping – wickers and things like that."

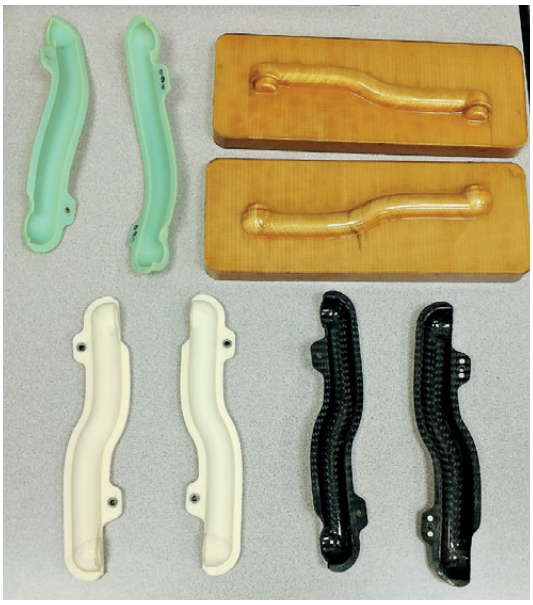
> *As the technology develops, the incentives to choose additive manufacturing over traditional technology increase*

Busier than ever

Standardised aero kits in IndyCar and the homologated Next Gen design in NASCAR may have brought a period of stability and less work on the aero side, but Penske's additive manufacturing department is now busier than ever. "Our partnership with Stratasys remains a strong and important one, especially as we continue to develop and test models for use across all the different racing series we compete in," says Chris Wilson, Director of Marketing, Team Penske. "The addition of the NEO 800 machine provides us with one of the best 3D printing machines on the market, and along with the amazing technical support from the experts at Stratasys, our production program continues to make gains year-over-year.

"Last year was one of the most successful seasons that Team Penske has had, culminating in the ultimate success, winning both titles in the NTT INDYCAR SERIES Championship and the NASCAR Cup Series Championship. These results wouldn't be possible without our partnership with Stratasys."

As the technology develops, the range of applications and the incentives to choose additive manufacturing over traditional technology continues to increase. And it still feels like a little slice of the future brought into the present day.



RIGHT Parts produced for a NASCAR fuel rail insulation project: the green parts are printed prototype parts for mock-up; the white parts are drill jigs; the yellow is the printed mold; and the resulting carbon part is shown bottom right

BELOW The advent of carbon fibre-reinforced nylon materials, such as Nylon 12CF, has enabled more 3D printed components to be used directly on the car

Giorgio Piola

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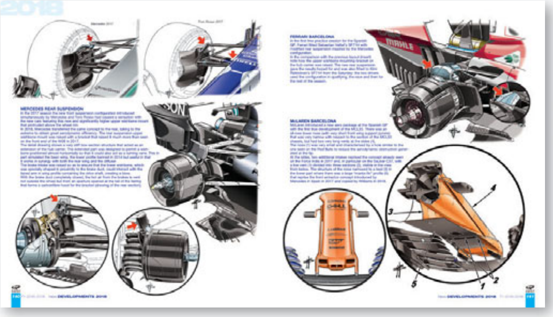

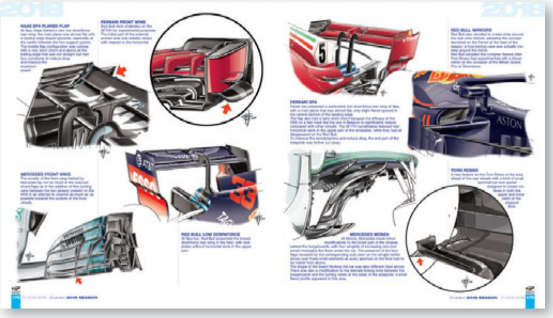

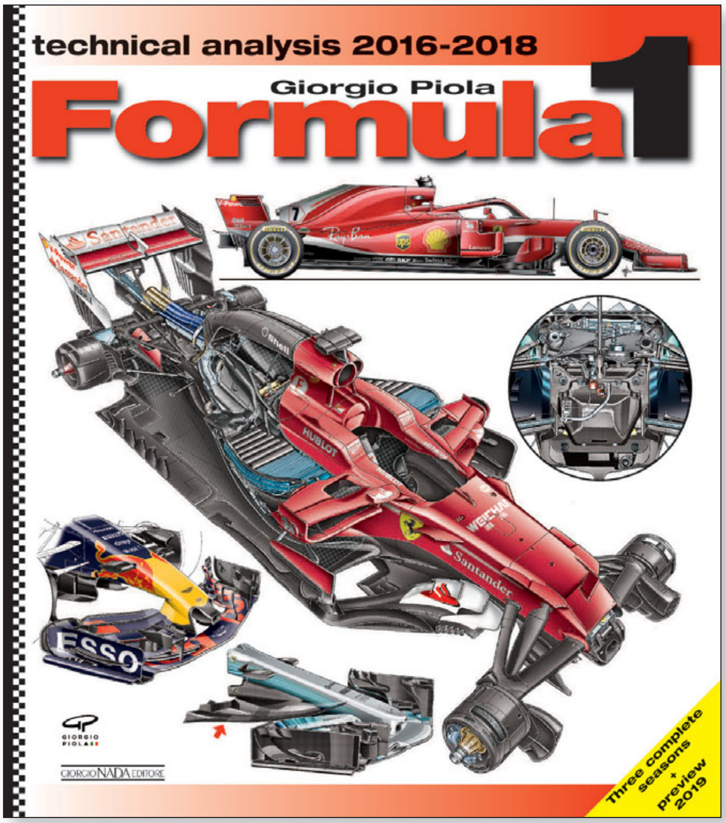
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LEFT The MPS4232 Miniature Pressure Scanner self-checks its own calibration regularly to remove any system offsets that may appear

NEW MINIATURE PRESSURE SCANNER LAUNCHED WITH ZERO OFFSETTING CAPABILITY

The ability to install the latest Scanivalve MPS4232 Miniature Pressure Scanner closer to measurement points could prove invaluable in wind tunnel testing. By **Mark Skewis**

THE MPS4232 miniature pressure scanner represents the forefront of pressure measurement technology. It has been designed from the ground up with size, accuracy, speed, and functionality in mind. This new scanner boasts 32 discrete pressure channels, a small footprint, TCP/IP Ethernet connectivity, an A/D per channel, synchronous scanning, and a wealth of other innovative features.

The MPS4232 electronics are designed around a high performance dual-core processor which can produce engineering unit data for 32 pressure channels synchronously at rates in excess of 1000 Hz (samples per channel per second). Onboard flash memory stores the pressure-temperature matrix that allows for the conversion of RAW 24-bit A/D counts to precise engineering unit data over a wide operating temperature (0-70°C).

The goal of the MPS4232 was to provide a high-channel, accurate, all-in-one data acquisition system in the smallest footprint possible. Using the legacy ZOC22b as a starting point, the MPS4232 includes many additional features that make it superior to the legacy ZOC-style scanners, including built-in electronics with a dual-core processor, one 24-bit A/D per transducer, Ethernet connectivity, and removeable input headers.

The MPS4232 is easy to use and will quickly integrate into your system. There is an integrated web server allowing the user to configure and operate the unit(s) from any device on the network.

Changing the game

Until now, the Scanivalve MPS4264 had established itself as the de facto wind tunnel pressure scanner in the years since its release, its combination of features and measurement performance having made it the ideal pressure scanner for the wind tunnel. Most new tunnels built in recent years have used this unit as the backbone of their measurement system.

The new Scanivalve MPS4232 utilises the same concepts and is fully compatible with the same data acquisition systems, for ease of installation and measurement system integrity. Crucially, it has a lower channel count and hence a much smaller footprint. This complements the larger unit perfectly, but allows installation in much smaller spaces, places where it may not have been possible to measure in this way before.

The new product's ease of installation benefits the existing MPS user who may wish to add channels that are easier to locate, or just to add a small number of channels to the existing measurement system philosophy.

Paul Crowhurst, Managing Director at Evolution Measurement, says, "The MPS4232 is an exciting development in Scanivalve's miniature pressure scanner range. It offers greater accuracy, synchronous measurement reading from each sensor and features the dynamic zero capability, which effectively zero offsets every measurement.

"This pressure scanner is ideal for wind tunnel testing environments and flight-testing applications."

Evolution Measurement are experts in industries that require highly accurate physical measurement, instrumentation and calibration. Based in Andover, UK, they represent Scanivalve Corporation and Guildline Instruments and provide bespoke solutions in multi-point pressure and temperature measurement, as well as engineering automated calibration and test systems and turnkey measurement solutions.

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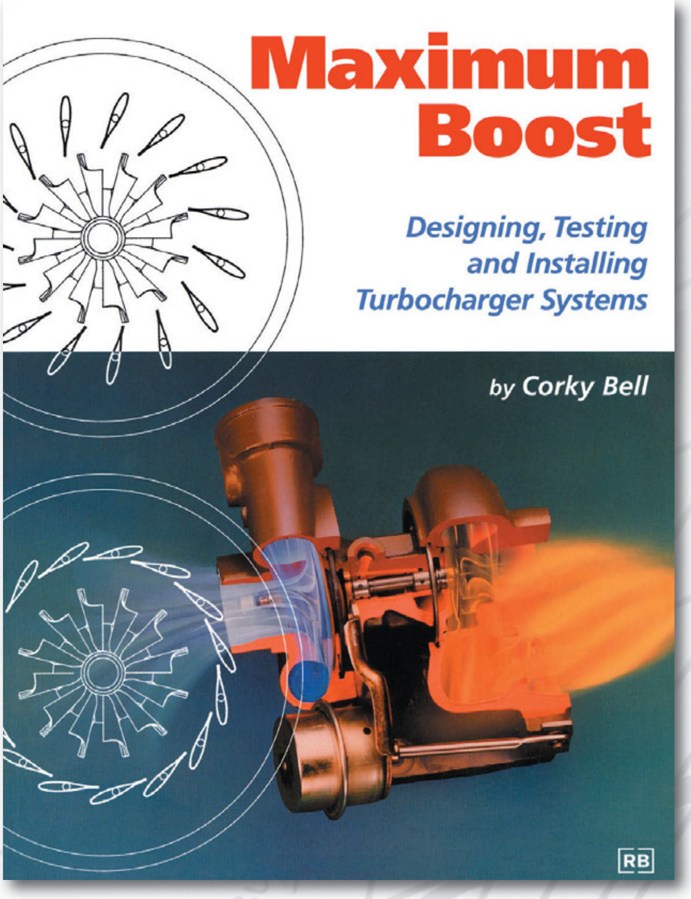

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YOU CAN COUNT THE SUCCESSFUL FERRARI TEAM PRINCIPALS ON ONE HAND – AND *STILL* HAVE ONE FINGER LEFT!

Ferrari

Sergio Rinland explains why former Ferrari chief Mattia Binotto had the nightmare job

FORMULA 1 Team Principals are not what they used to be. Save for a couple of exceptions, current F1 Team Principals are employees; well-paid and empowered employees, but employees nonetheless.

When I worked in F1, and long before that, we used to work for the man who happened to be the team owner. At Williams, you 'worked for Frank', at Brabham you 'worked for Bernie', at McLaren you 'worked for Ron', at Tyrrell you 'worked for Ken' or at Lotus you 'worked for Colin'. Those were different times and certainly different characters. Today, F1 personnel work for the companies, including the Team Principal.

Those team owners were real characters, most of them self-made persons, real leaders.

You could say that some Team Principals today are good leaders, but most of them are just good managers.

ABOVE Mattia Binotto: brilliant engineer but a casualty of Ferrari's propensity to self-destruct

What brings me to this subject today is the demise of Mattia Binotto at Ferrari and the subsequent crazy 'revolving door' season it triggered, with a flurry of departures and arrivals all the way down the F1 pitlane. Whether Binotto resigned or was forced to resign, does not matter: it amounts to the same. The role of Ferrari's Team Principal has always been, since the days of Nello Ugolini in the 1950s, a nightmare of a job.

Mismanagement by committee

Until 1988, they had to report to Il Commendatore Enzo Ferrari himself, not exactly a Carmelite nun. After Mr Ferrari's death in 1988, the Team Principals had to report to the FIAT board: from the pan into the fire!

In the 70-year history of Ferrari, you can count on one hand the successful Team Principals of either dynasty, and I *still* have one finger left: Luca di ▶

> *"They are not only representing a team: they carry the country on their shoulders"*

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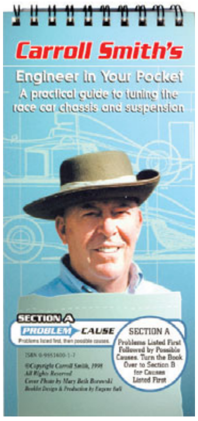
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Montezemolo, Marco Piccinini, Jean Todt and Stefano Domenicali.

The others were there for periods from less than a year to a maximum of three years. That tells us something about the difficulties of that job. As with a manager in the football World Cup, they are not only representing a team: they carry the country on their shoulders. And that country is Italy, which is renowned for the passion of its people, rather than their tolerance for failure. Some pressure there!

Ruthless

Those four names had something in common. All could swim comfortably in the shark's pool that is F1; they were strong characters, ruthless, good leaders of people, with knowledge of the business, and politically astute.

Did Mattia Binotto have all those traits? Probably not all of them, but he is a brilliant engine designer and engineer. So, this raises the question of why Ferrari, having one of the brightest minds in the Formula 1 engineering pool, made him a Team Principal? Because Formula 1 has the bad habit of promoting its best people to positions where they don't have the complete toolset, just to give them a promotion.

RIGHT Whoever runs the race team carries the expectations of a nation on their shoulders

Ferrari

BELOW Luca di Montezemolo: comfortable swimming with F1's sharks

Ferrari

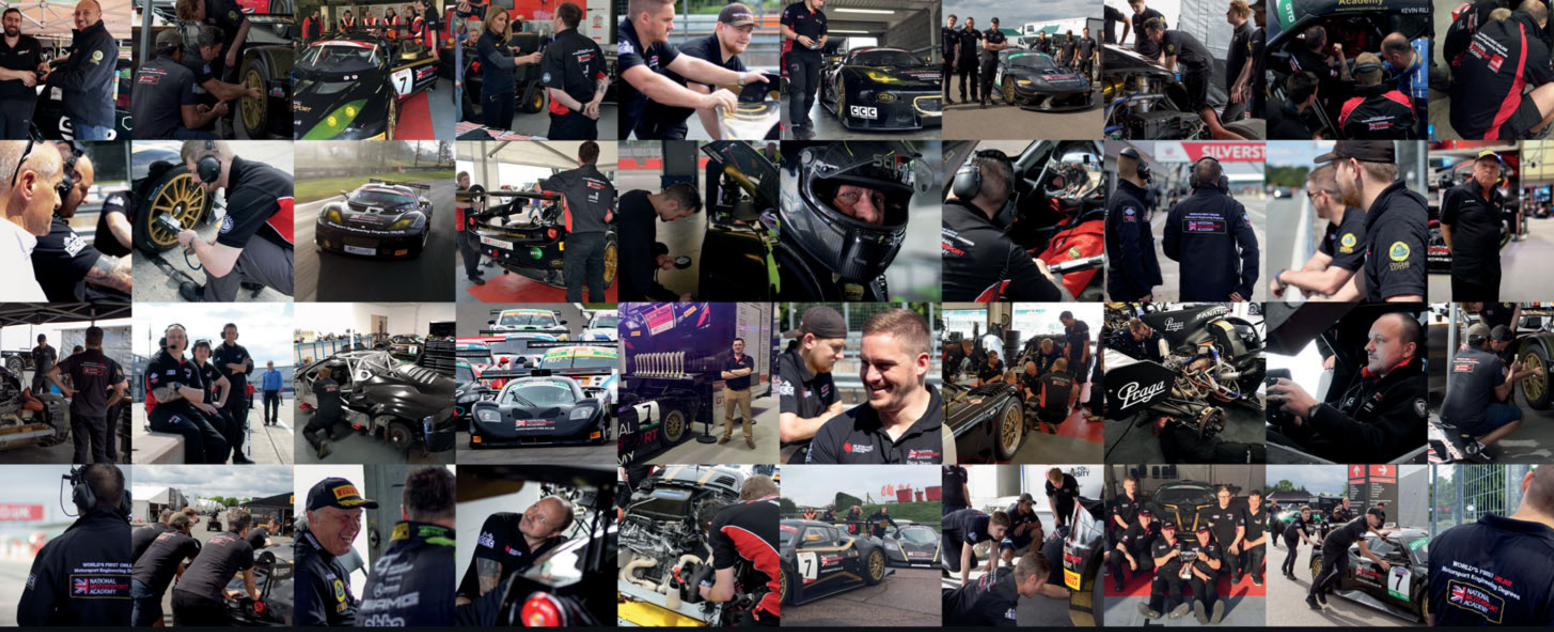
> *"Formula 1 has the bad habit of promoting its best people to positions where they don't have the complete toolset"*

Double trouble

That is why the best way to reward the right person who is at the top of his tree, is with juicy salaries and bonuses – not by transporting them to another tree they are unfamiliar with.

By sacking Binotto, Ferrari merely gave itself two problems: find an appropriate Team Principal AND a technical boss. If they don't perform in the next few years, it should be no surprise to anyone.

Like any Formula 1 fan, I am a 'Ferrari fan', so I truly hope to be wrong. RT



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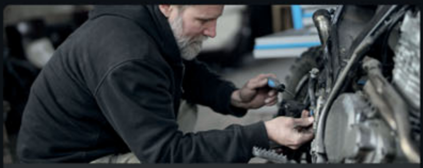

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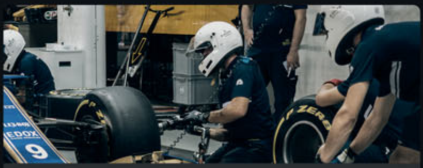

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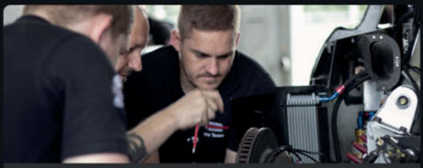

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